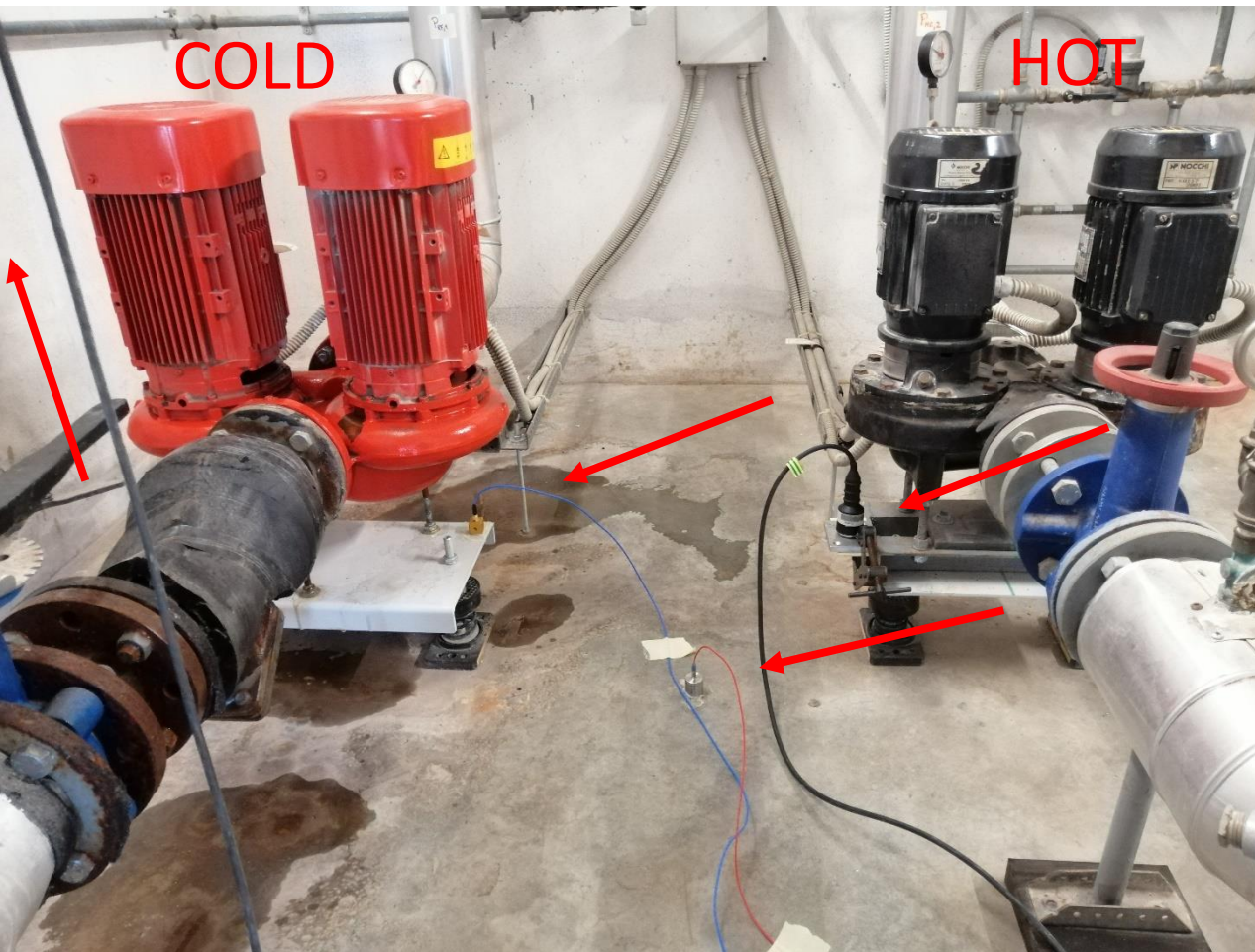


# WEB Hot water pump slowdown tests

Lorenzo Pierini

# Sensors added in pumps room



ENV\_WEB\_HOTPUMP\_OVER  
ENV\_WEB\_HOTPUMP\_FLOOR

ENV\_WEB\_HOTPUMP\_PIPE\_IN  
ENV\_WEB\_COLDPUMP\_OVER



INF\_WEB\_HEATER\_PRES\_IN  
INF\_WEB\_HEATER\_PRES\_OUT

# Sensors in WEB

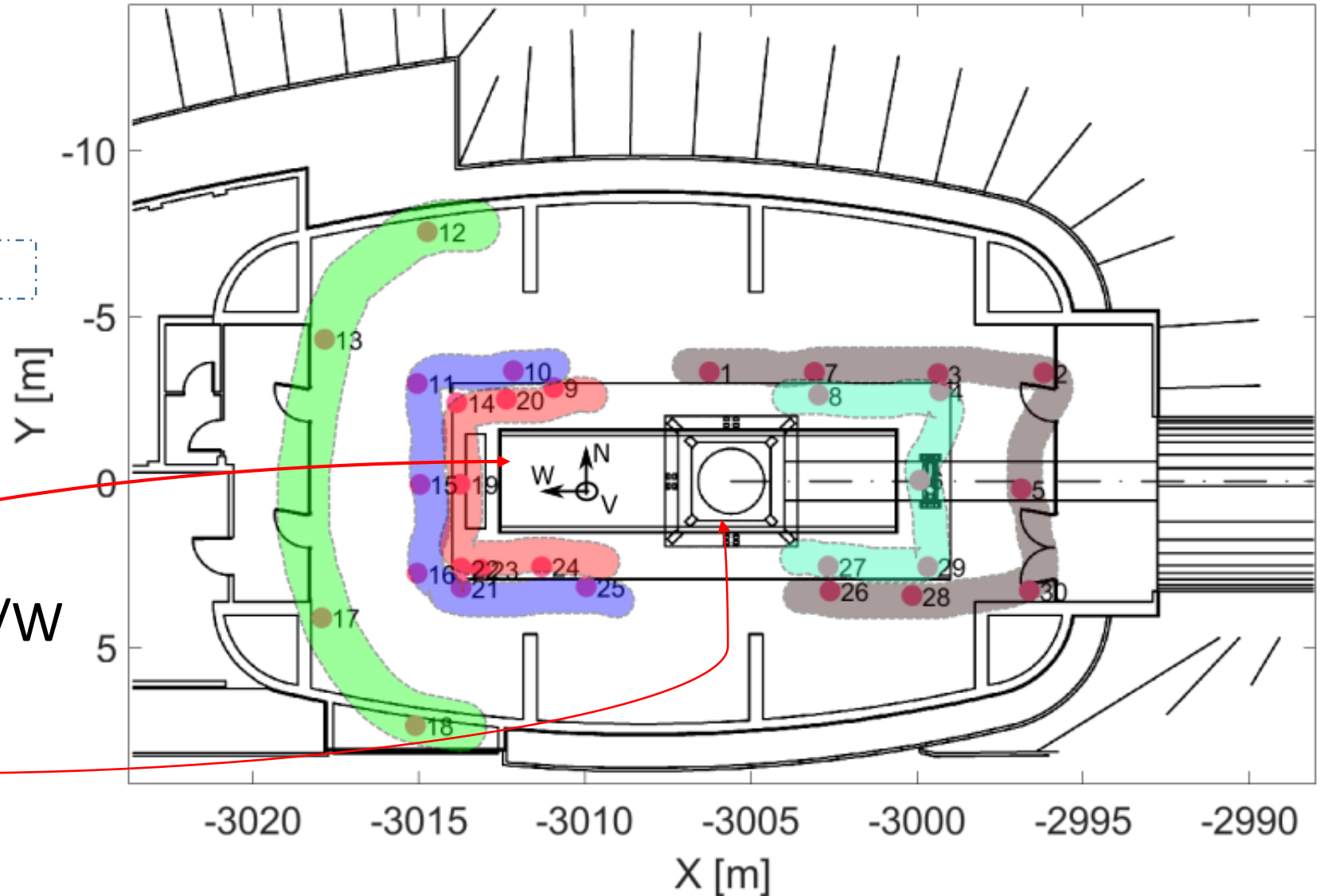


ENV\_WEB\_SEIS\_N/V/W

ENV\_WE\_ACC\_Z

ENV\_WE\_CT\_ACC\_Z

ENV\_WE\_ALS\_ACC\_Z



# Operations timeline

Wednesday 16/06/2021 at hot water pump

Time UTC	Description
12:28	we entered the WEB water pumps room
12:32:45	switch from right to left pump, at 50Hz
12:42:26	switch from left to right pump, at 45Hz
12:51:36	switch from right to left pump, at 45Hz
13:00:28	switch from left to right pump, at 40Hz
13:06	the security system shut down the boiler (low pressure)
13:07:47	the same right pump (no switch) is slowed at 35Hz
13:15	the supply of the right pump is increased from 35Hz at +1Hz steps: at 47Hz the boiler turns on
13:17	the supply of the right pump is decreased from 47Hz at -1Hz steps: at 40Hz the boiler turns off
13:18	the system is restored at the starting conditions (right pump at 50Hz); we leave the room.

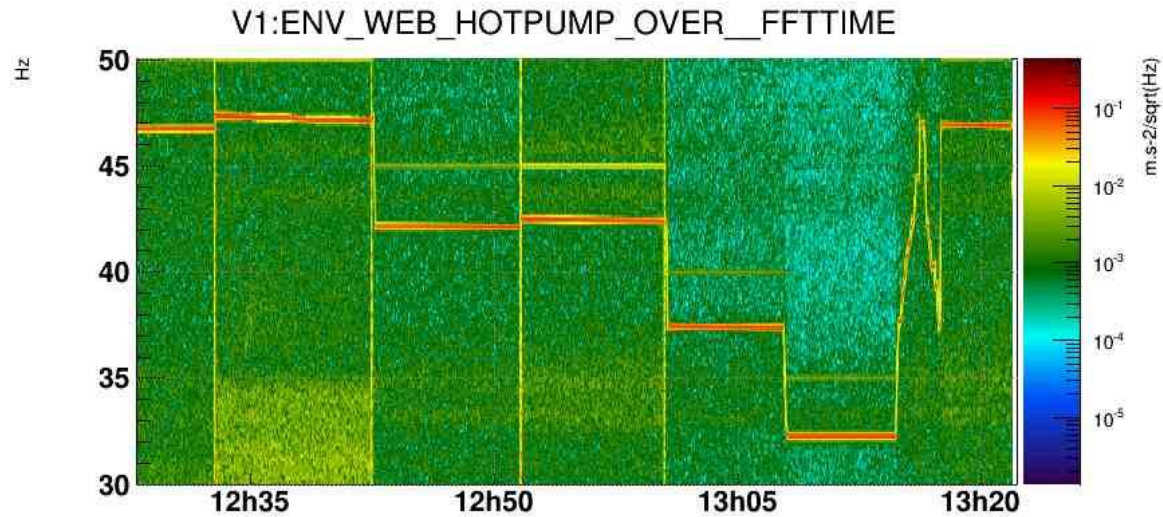
Thursday 17/06/2021 - long term test

08:49	Right hot pump slowed from 50Hz down to 45Hz
16:19	Right hot pump restored from 45Hz up to 50Hz

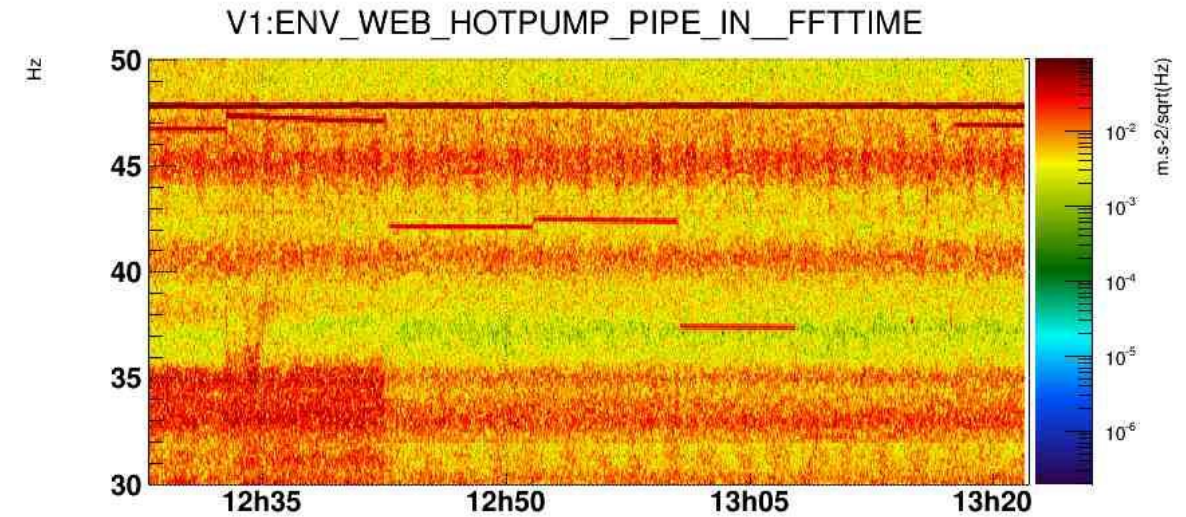


# Room accelerometers

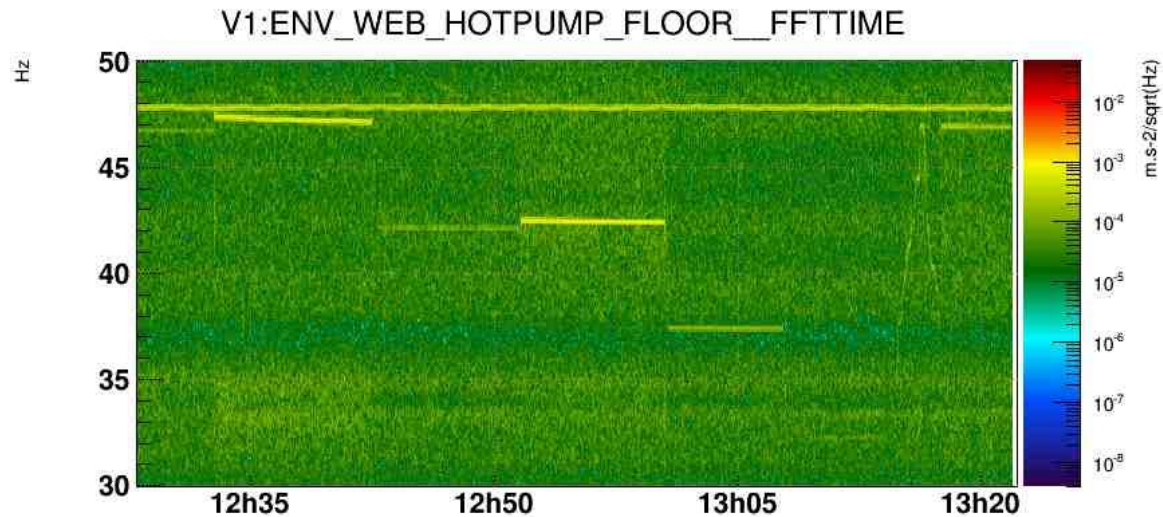
dataDisplay v10r9p2 : started by pierini on Jun 17 2021 07:27:55 UTC



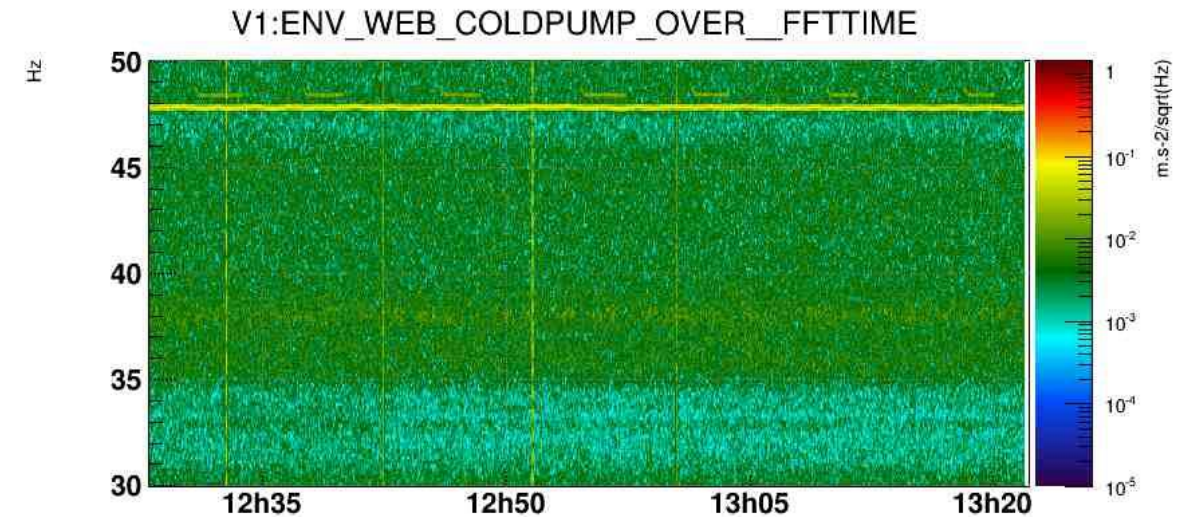
1307881696.0000 : Jun 16 2021 12:27:58 UTC dt:10.00s nAv:20



1307881696.0000 : Jun 16 2021 12:27:58 UTC dt:10.00s nAv:20

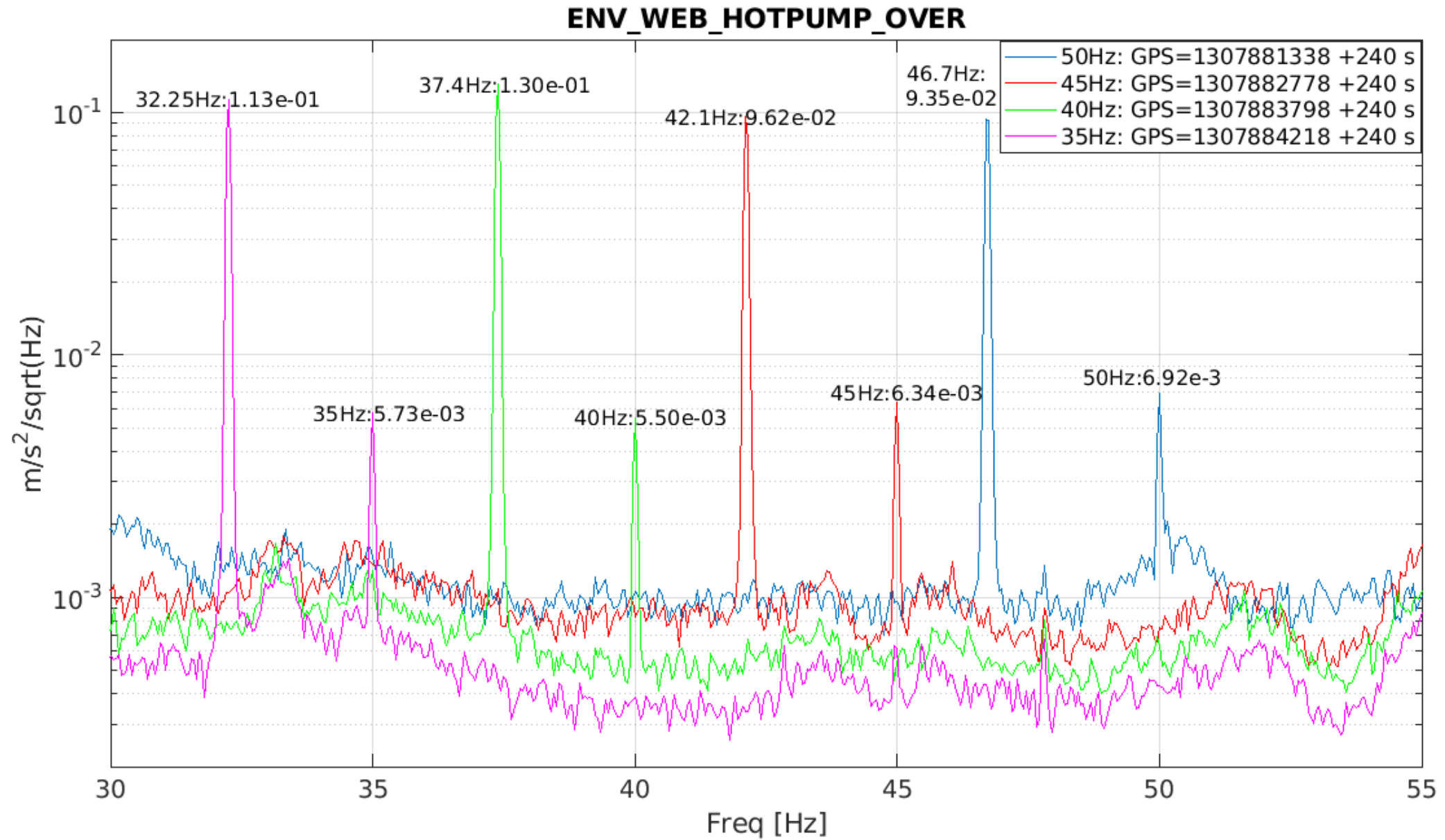


1307881696.0000 : Jun 16 2021 12:27:58 UTC dt:10.00s nAv:20



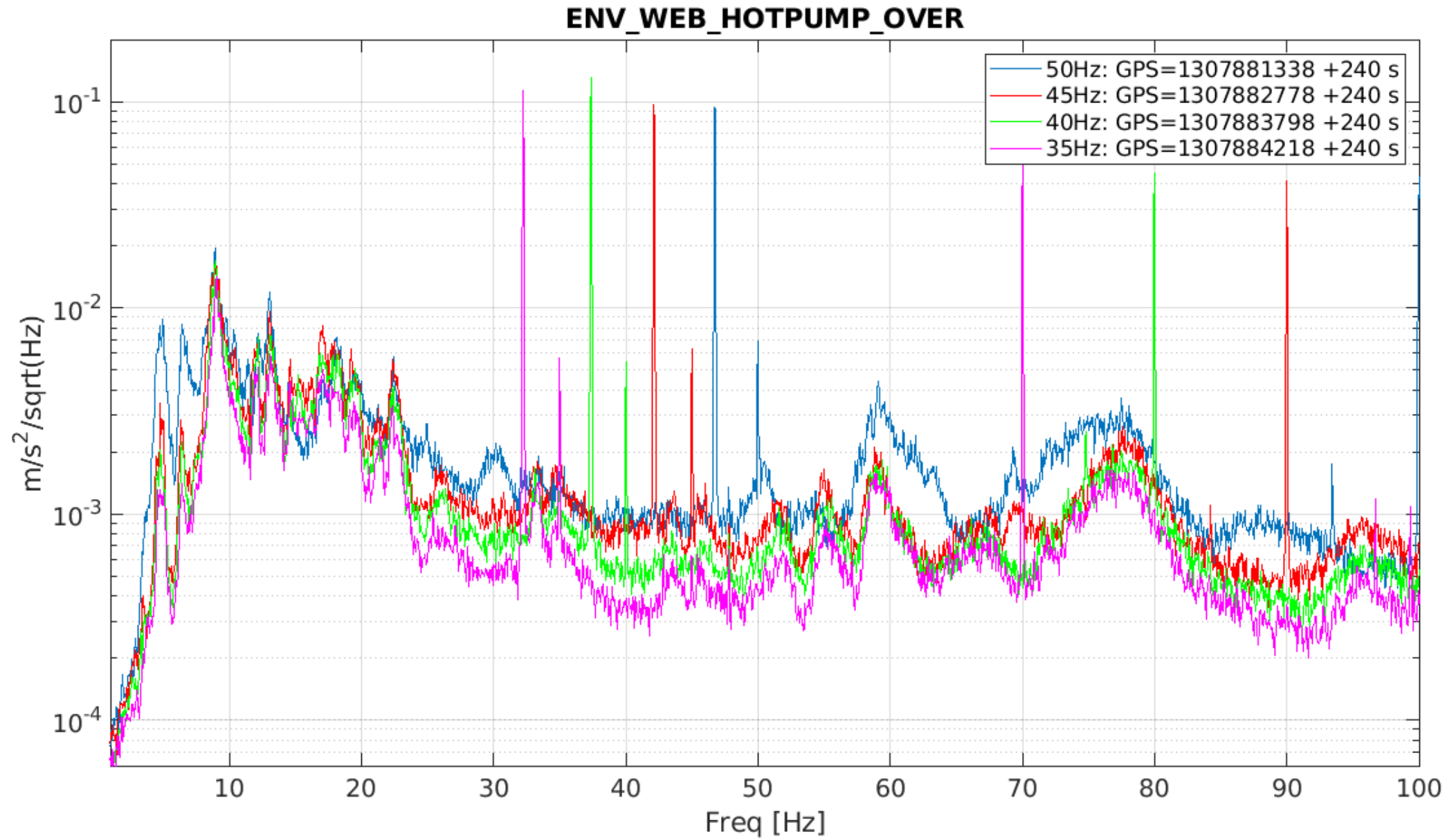
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# Room accelerometers

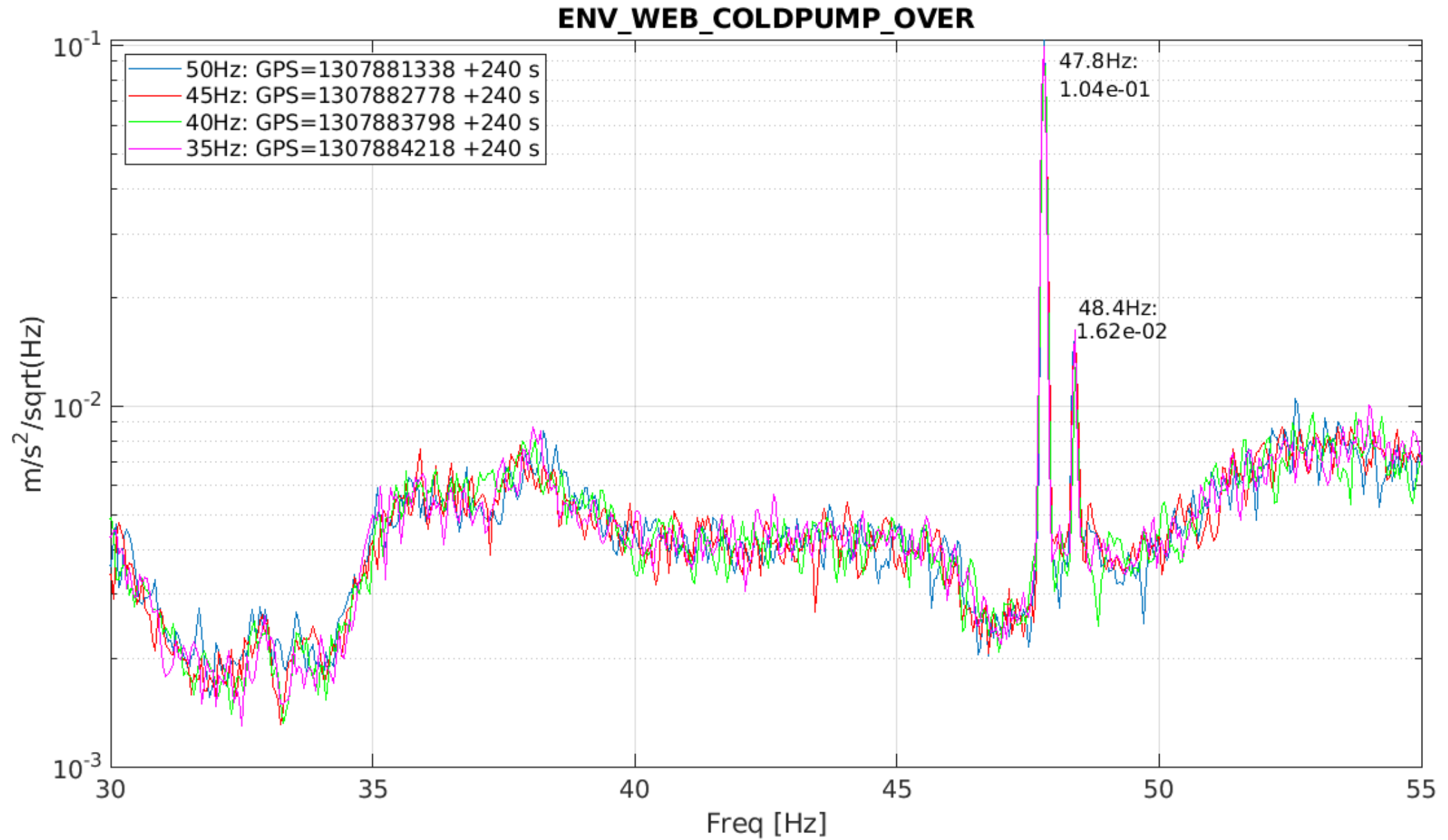




# Room accelerometers

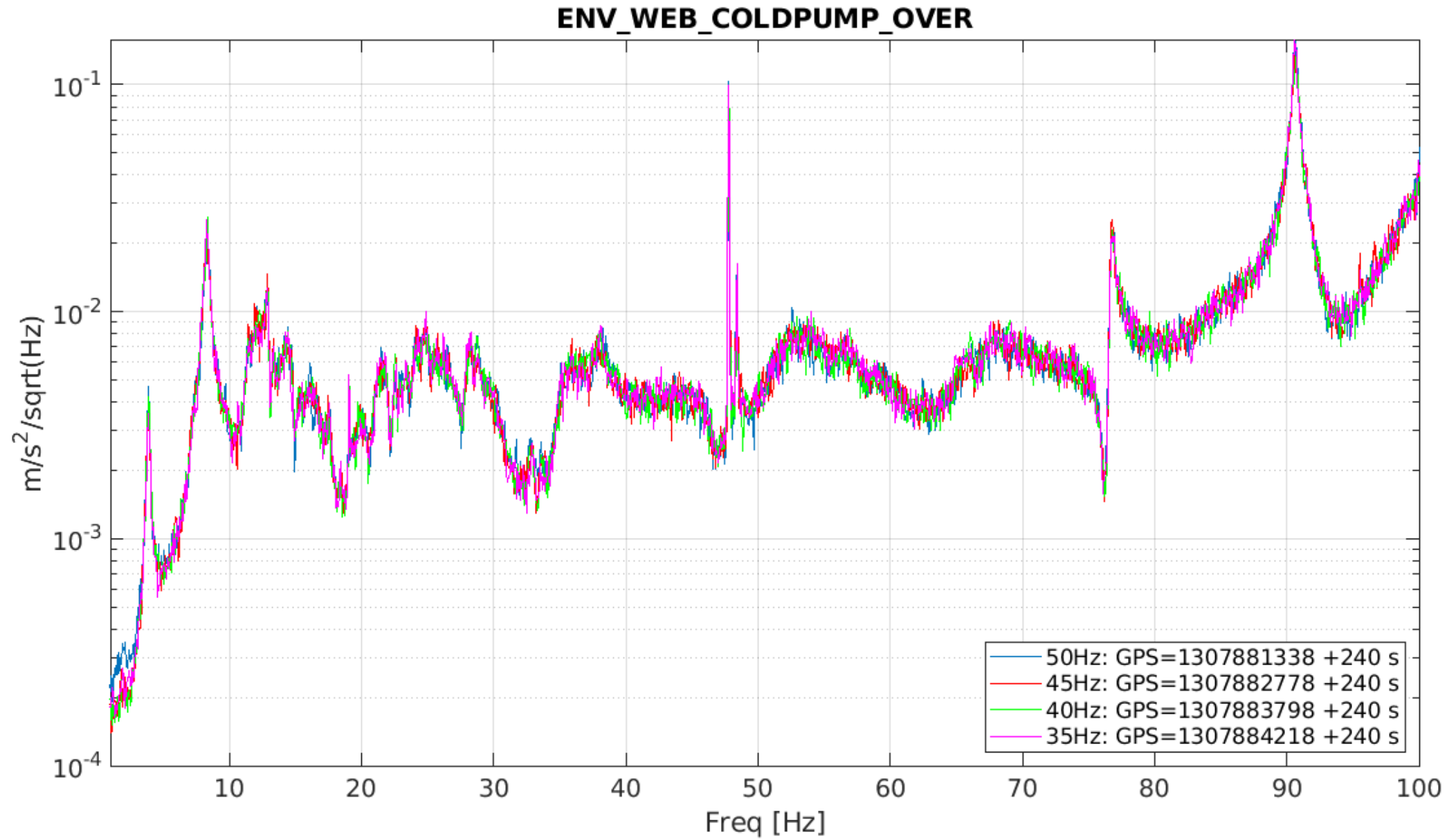


# Room accelerometers

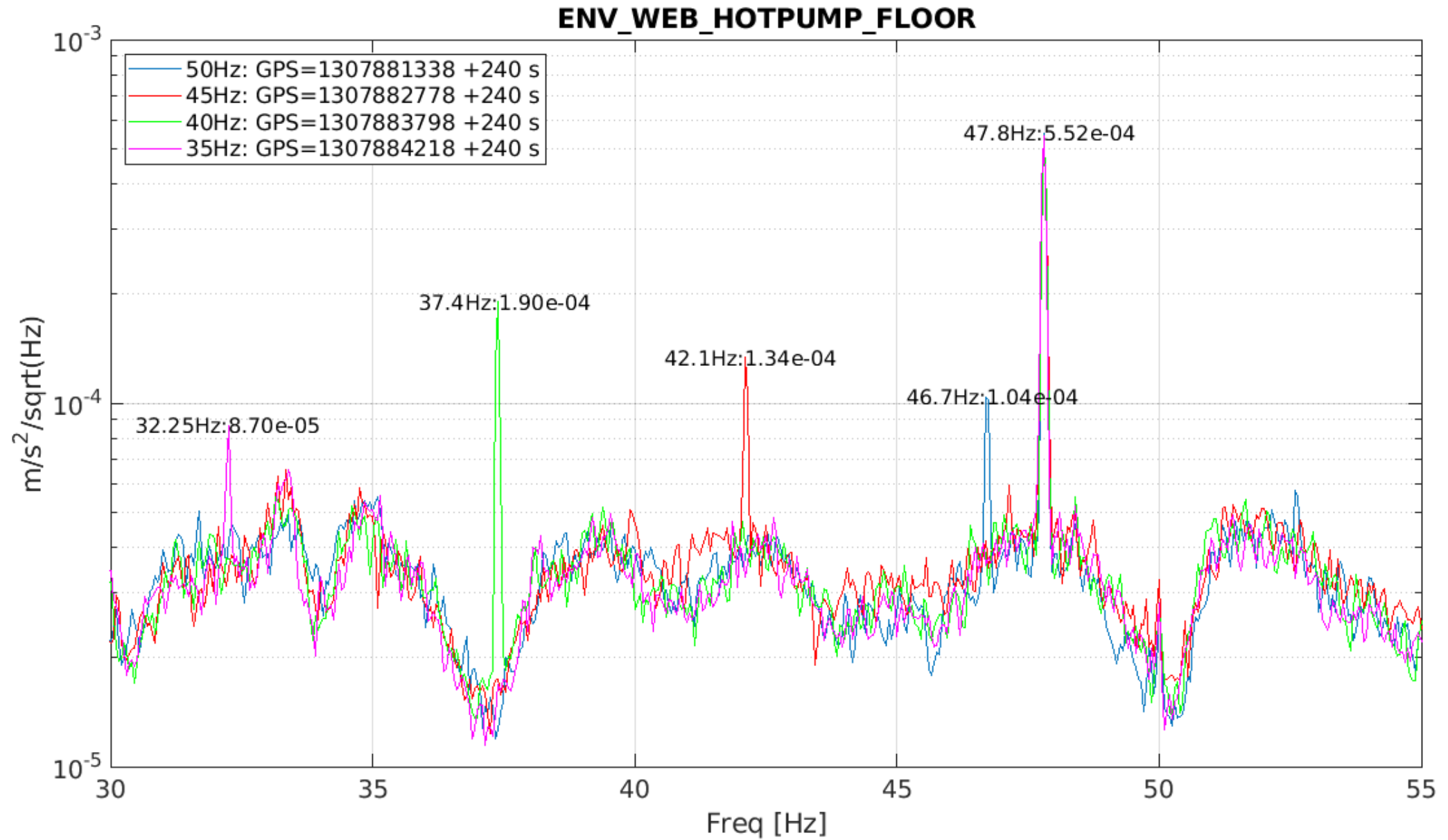




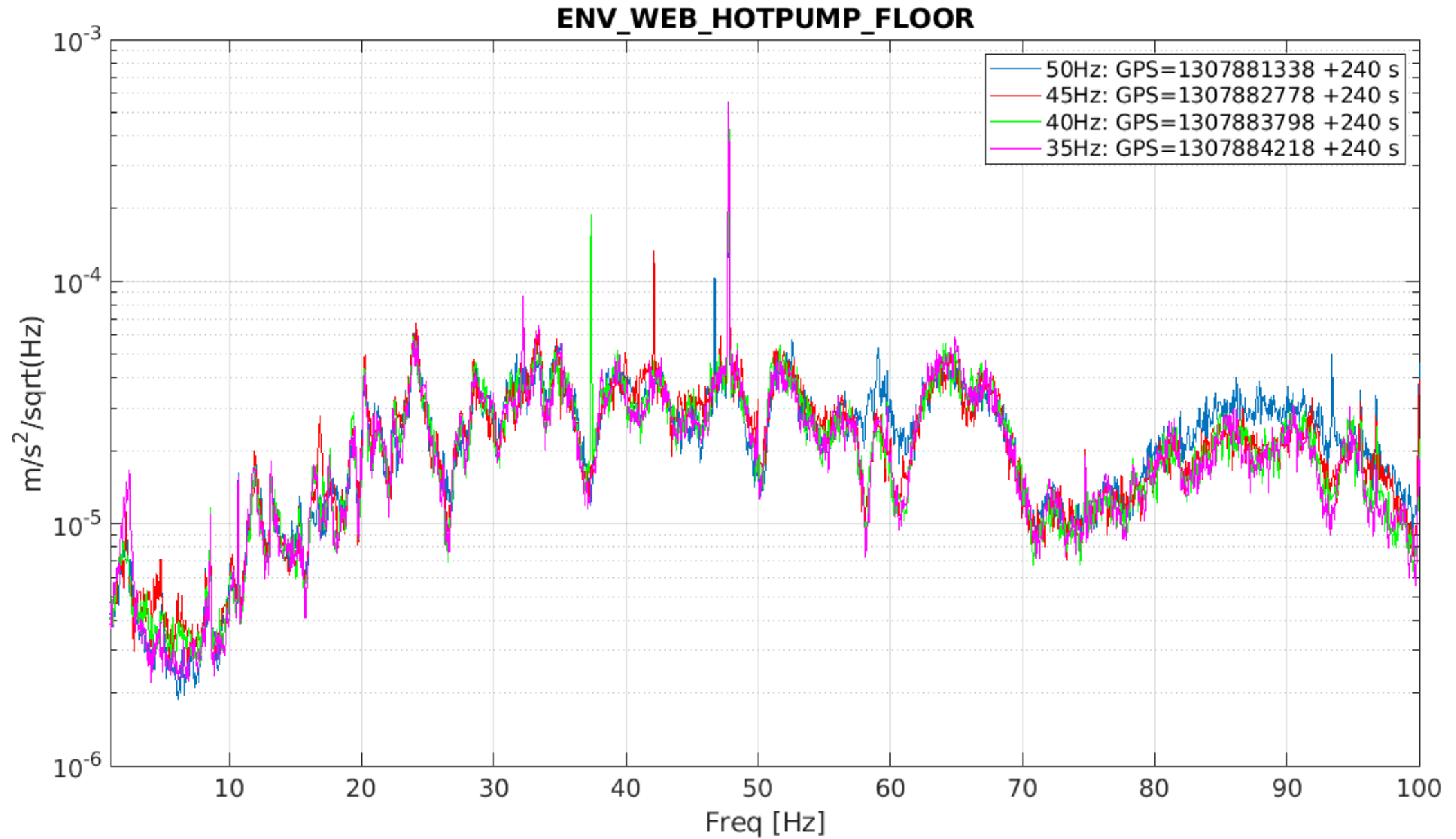
# Room accelerometers



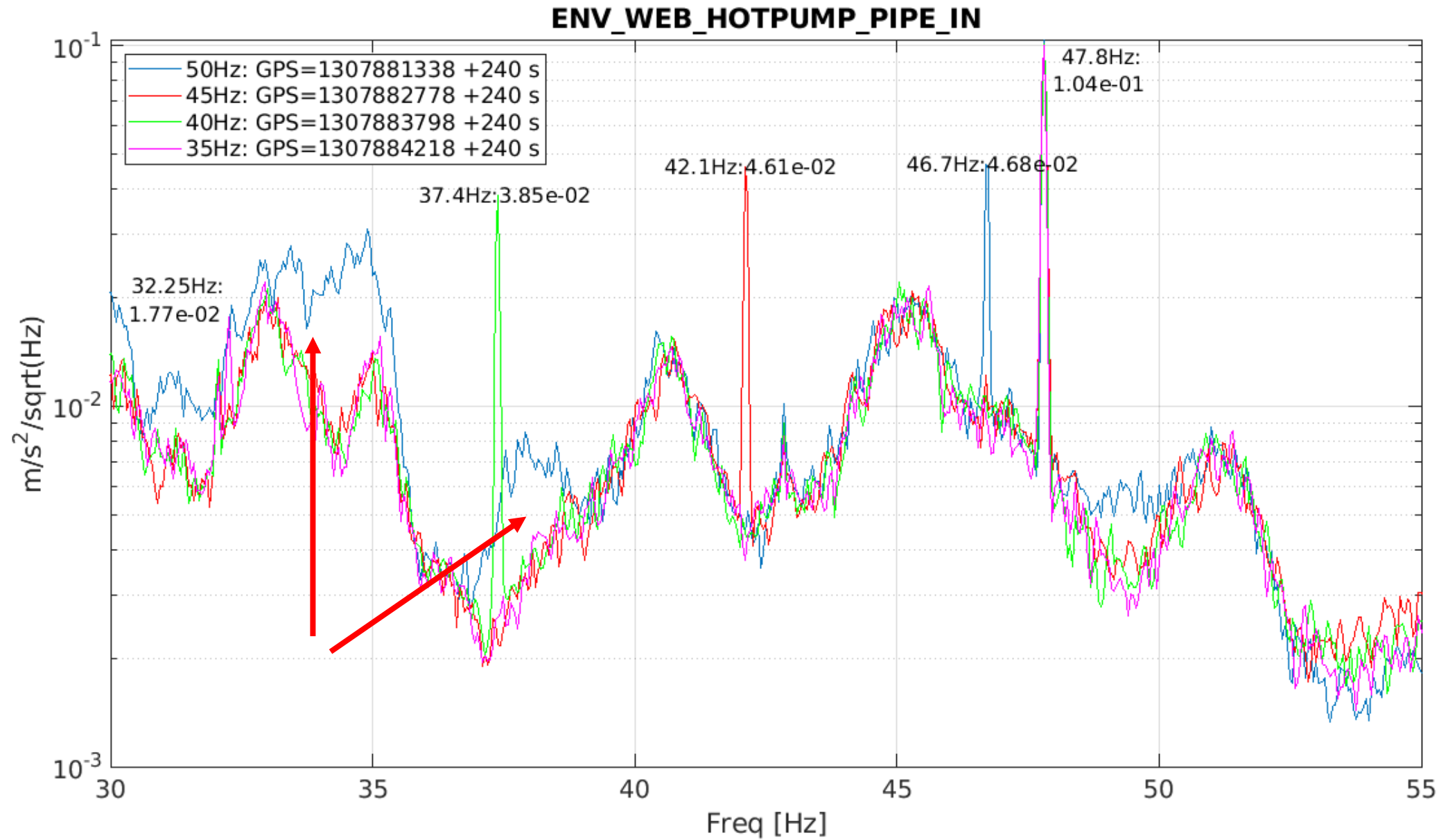
# Room accelerometers



# Room accelerometers

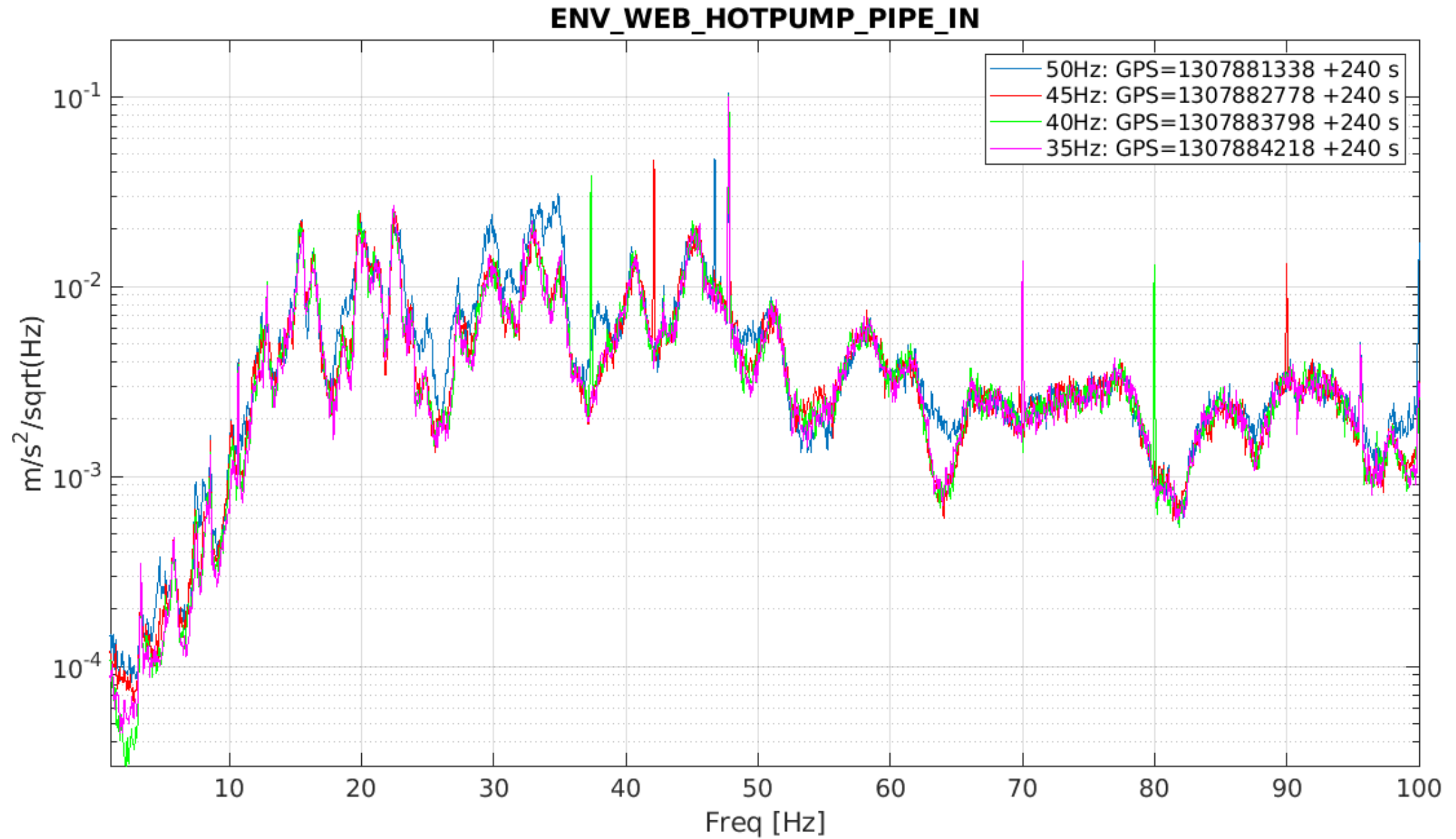


# Room accelerometers



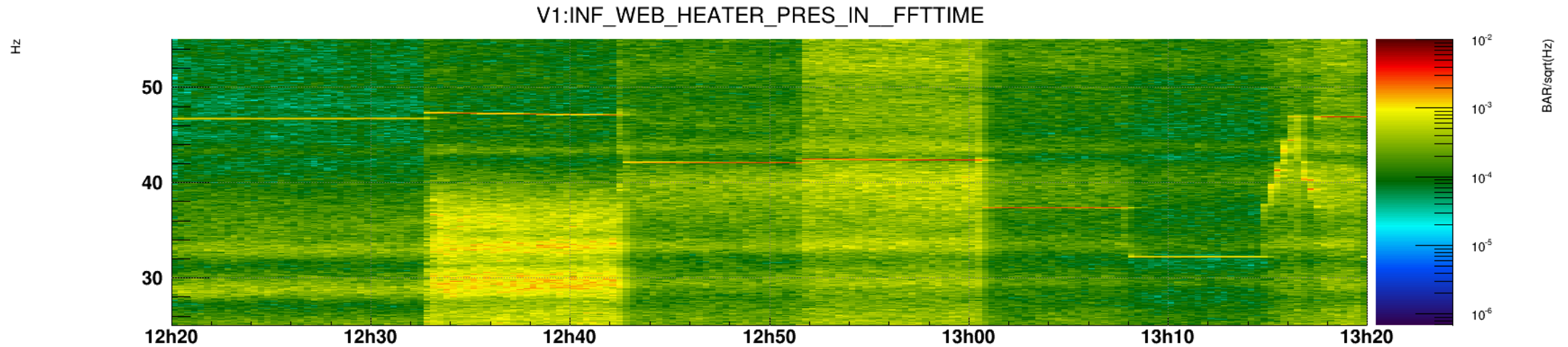


# Room accelerometers

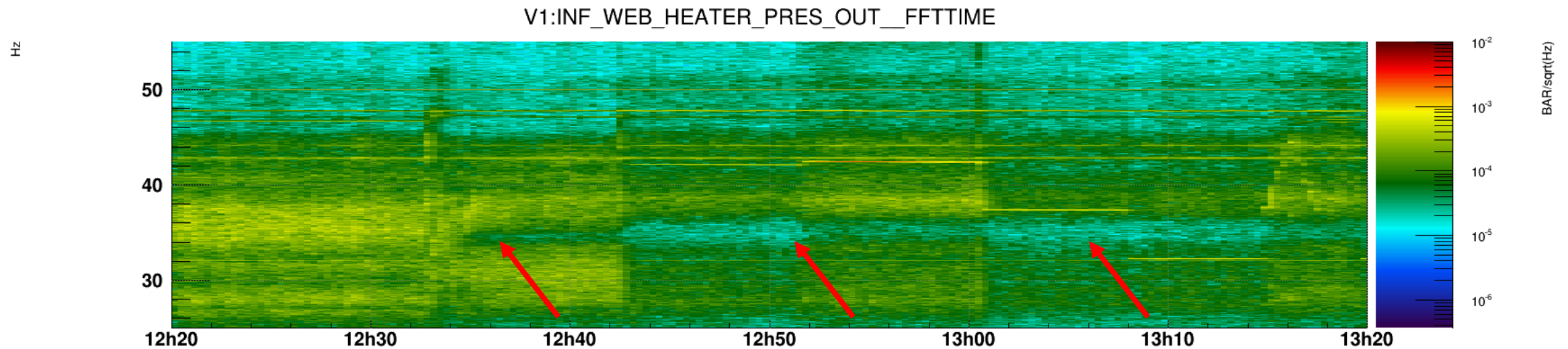


# Heater flux sensors

dataDisplay v10r9p2 : started by pierini on Jun 23 2021 09:17:49 UTC

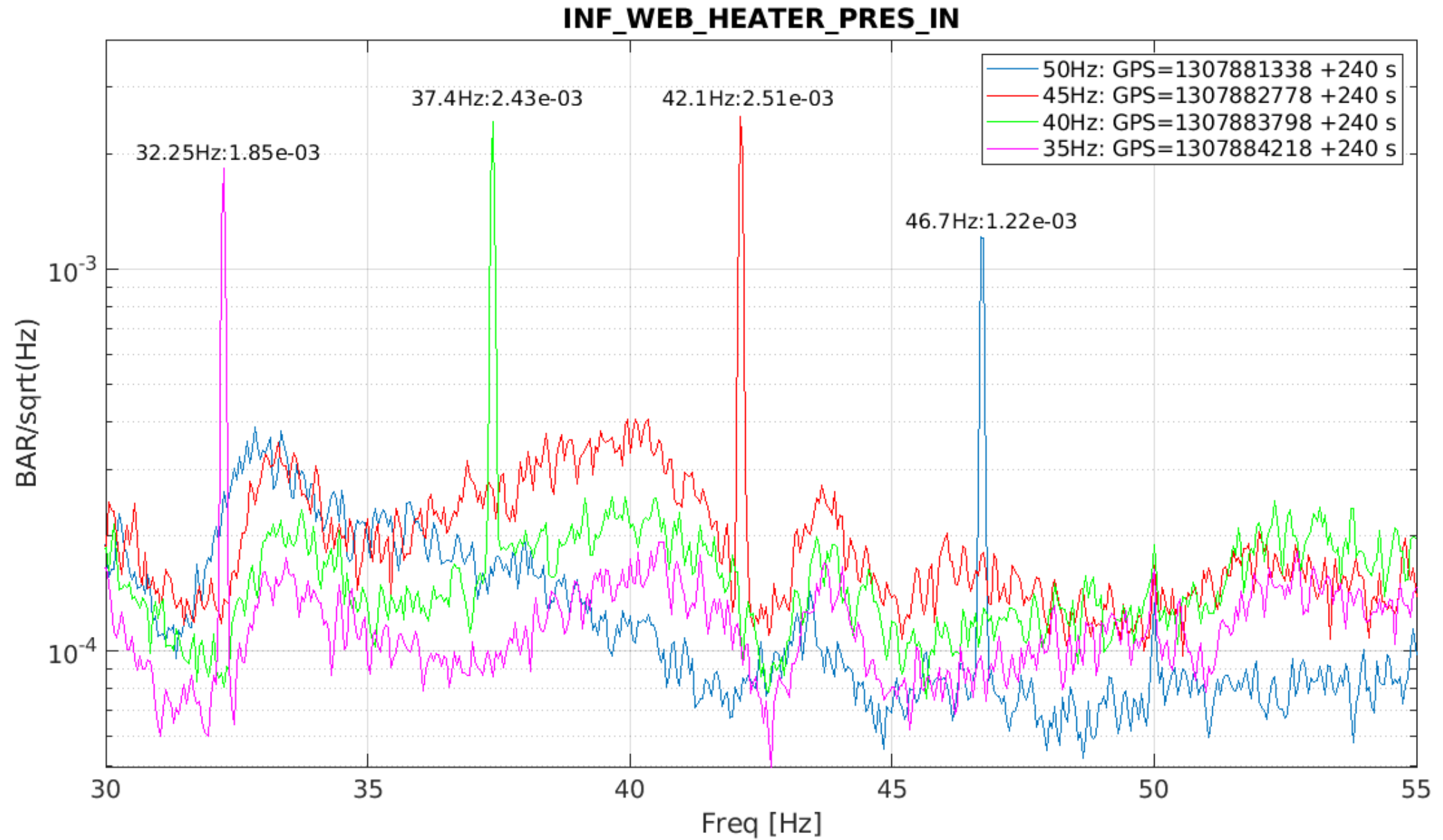


1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

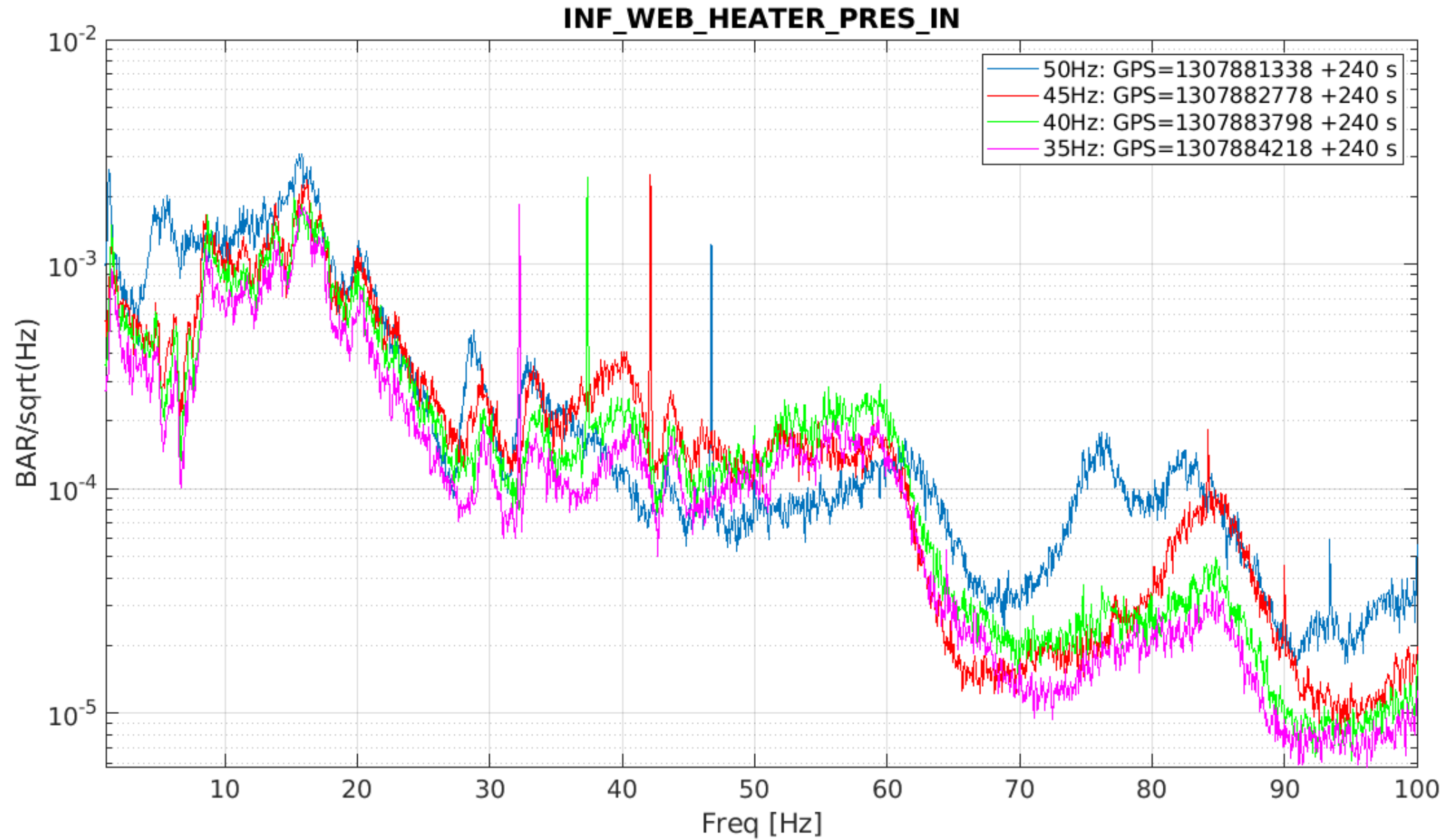


1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

# Heater flux sensors

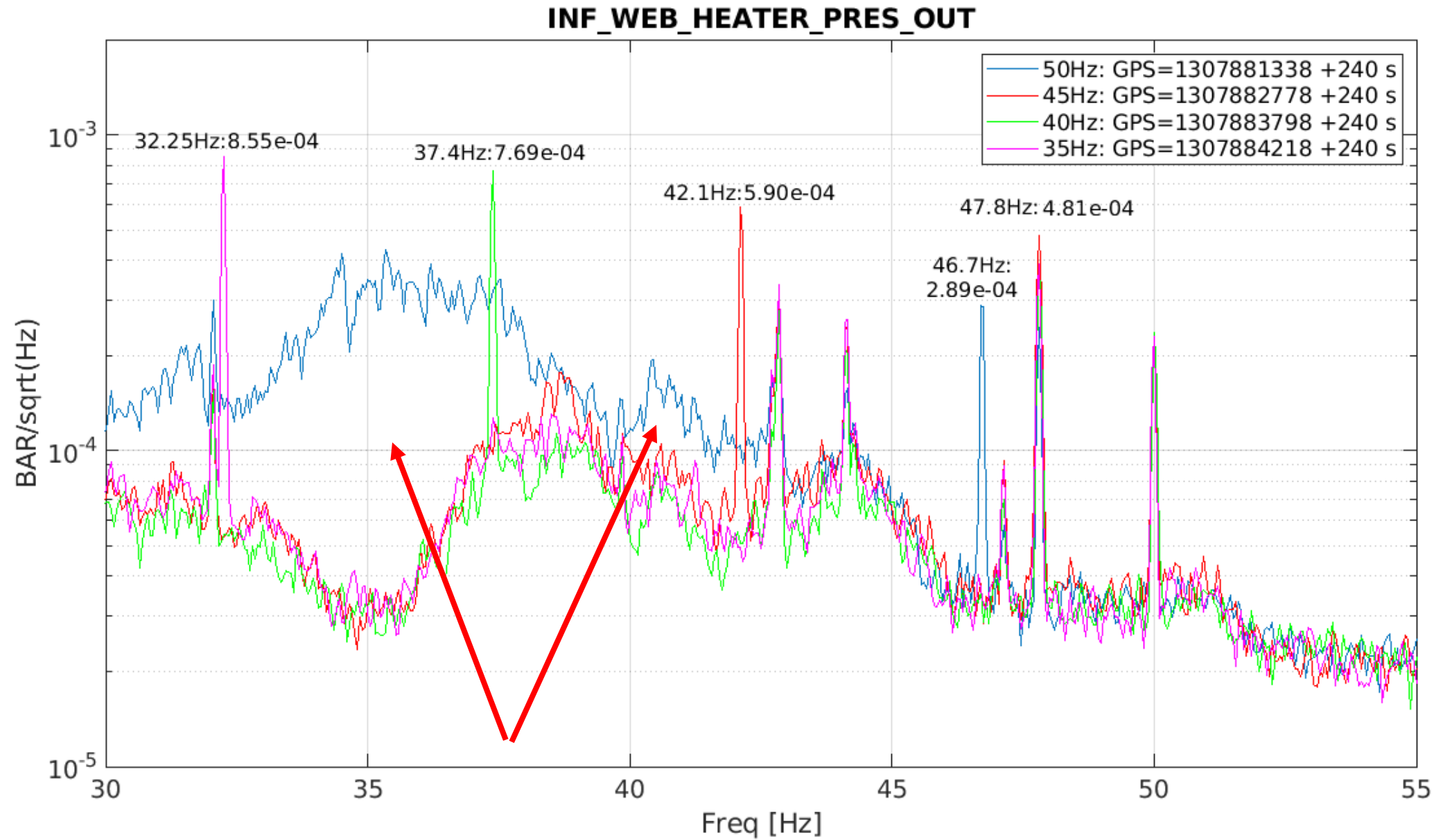


# Heater flux sensors

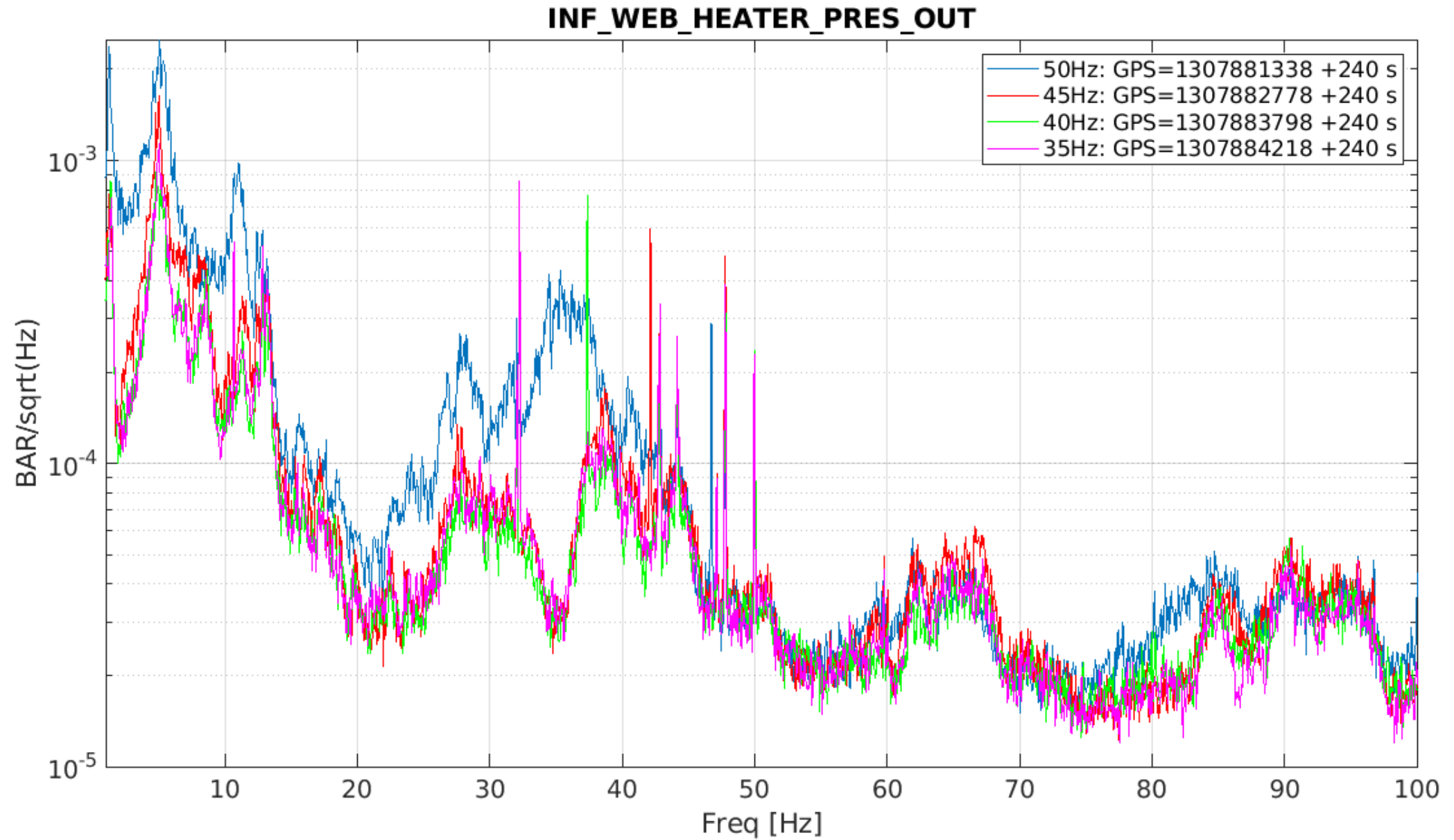




# Heater flux sensors

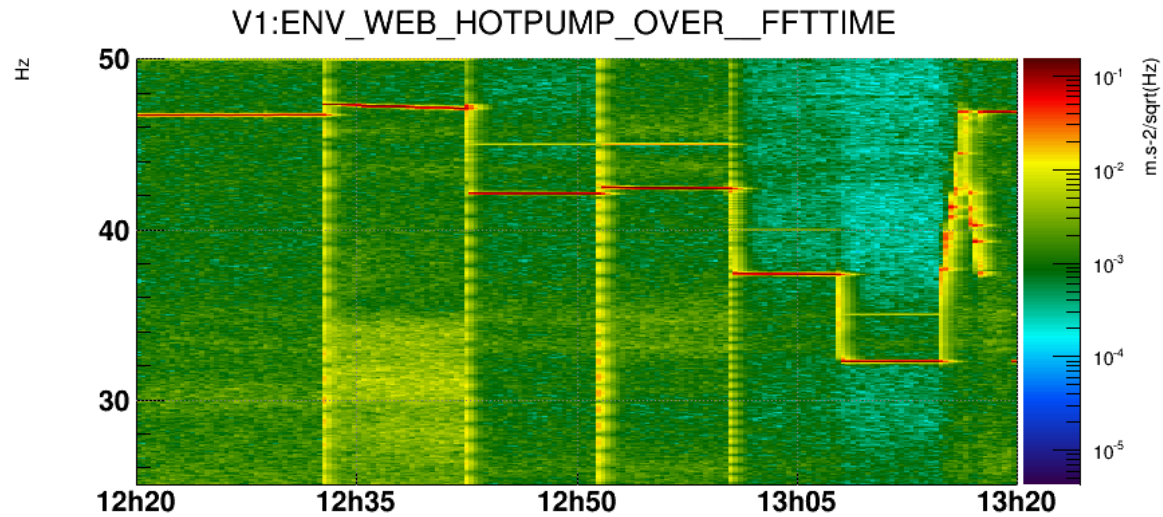


# Heater flux sensors

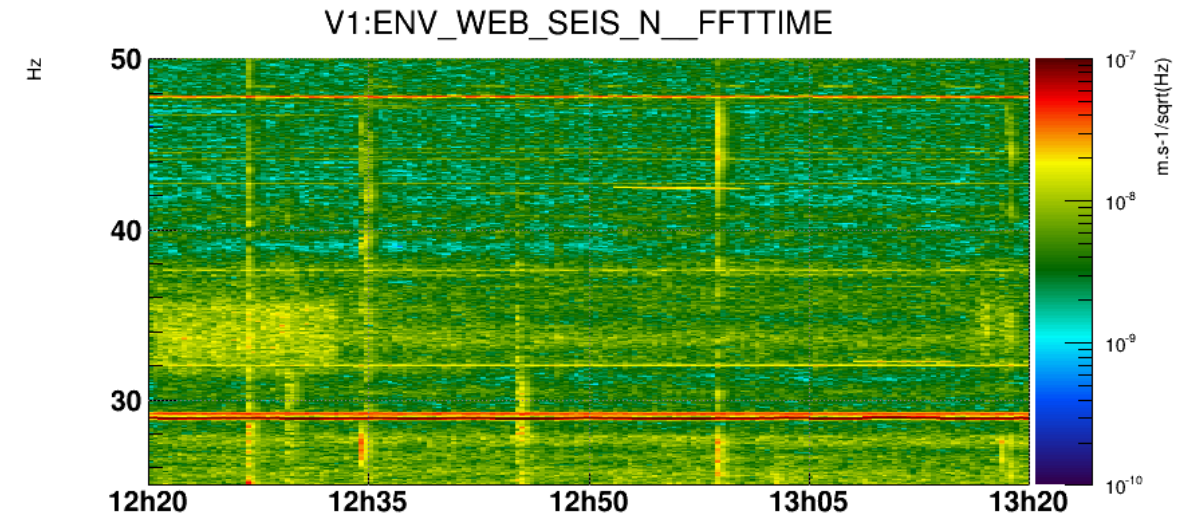


# Guralp seismometer

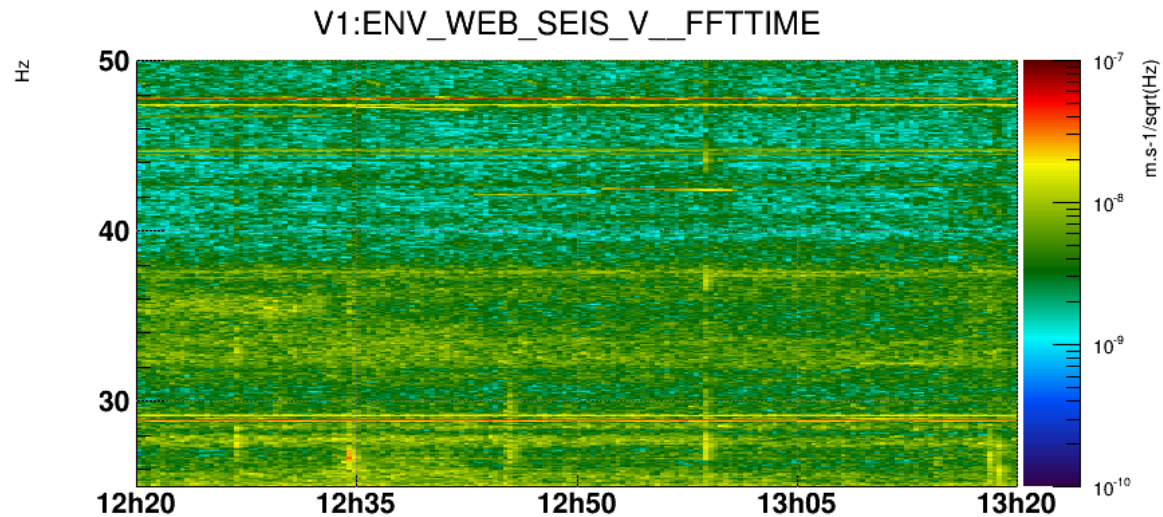
dataDisplay v10r9p2 : started by pierini on Jun 23 2021 10:27:06 UTC



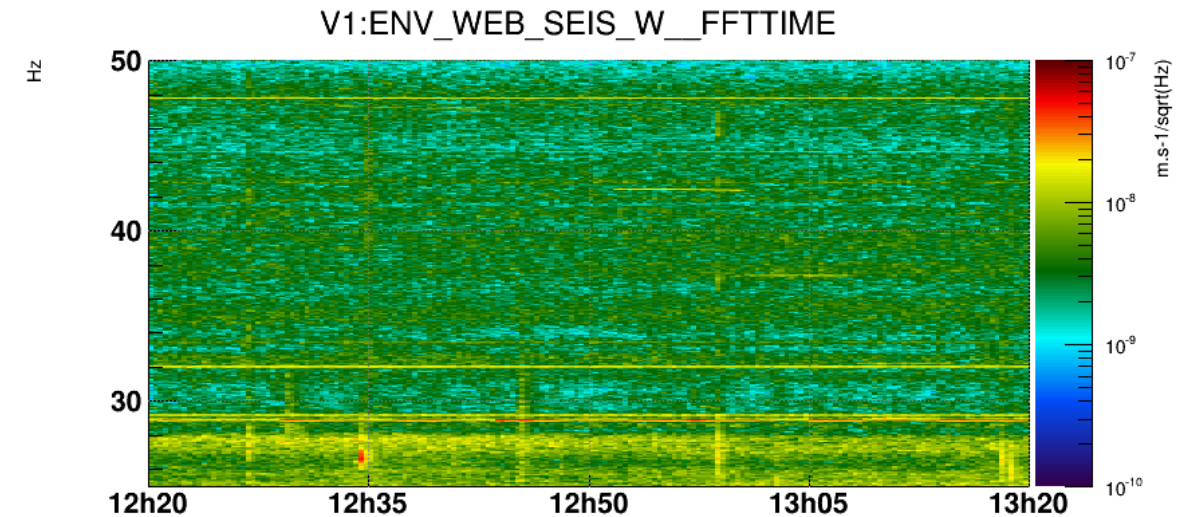
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

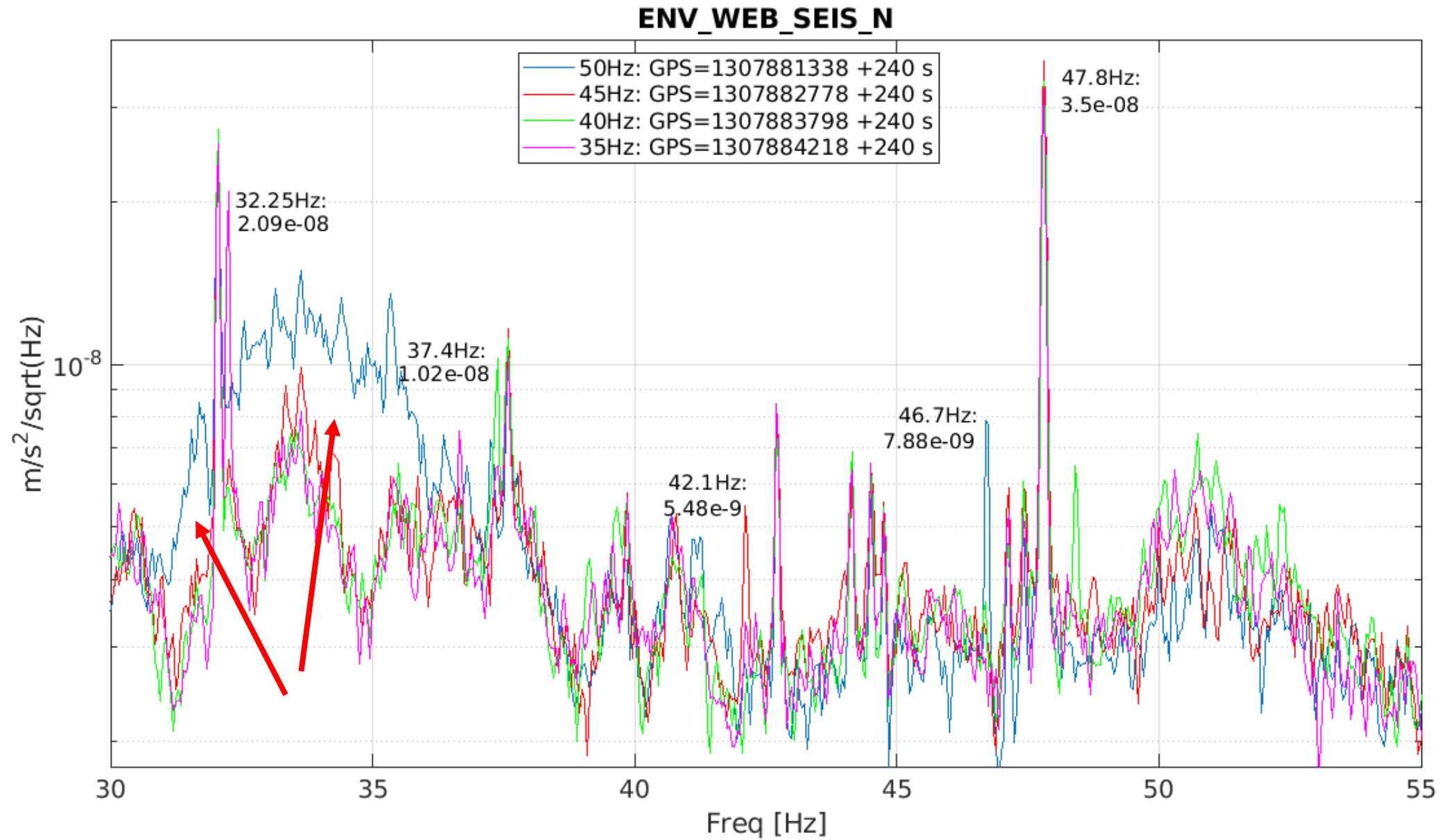


1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



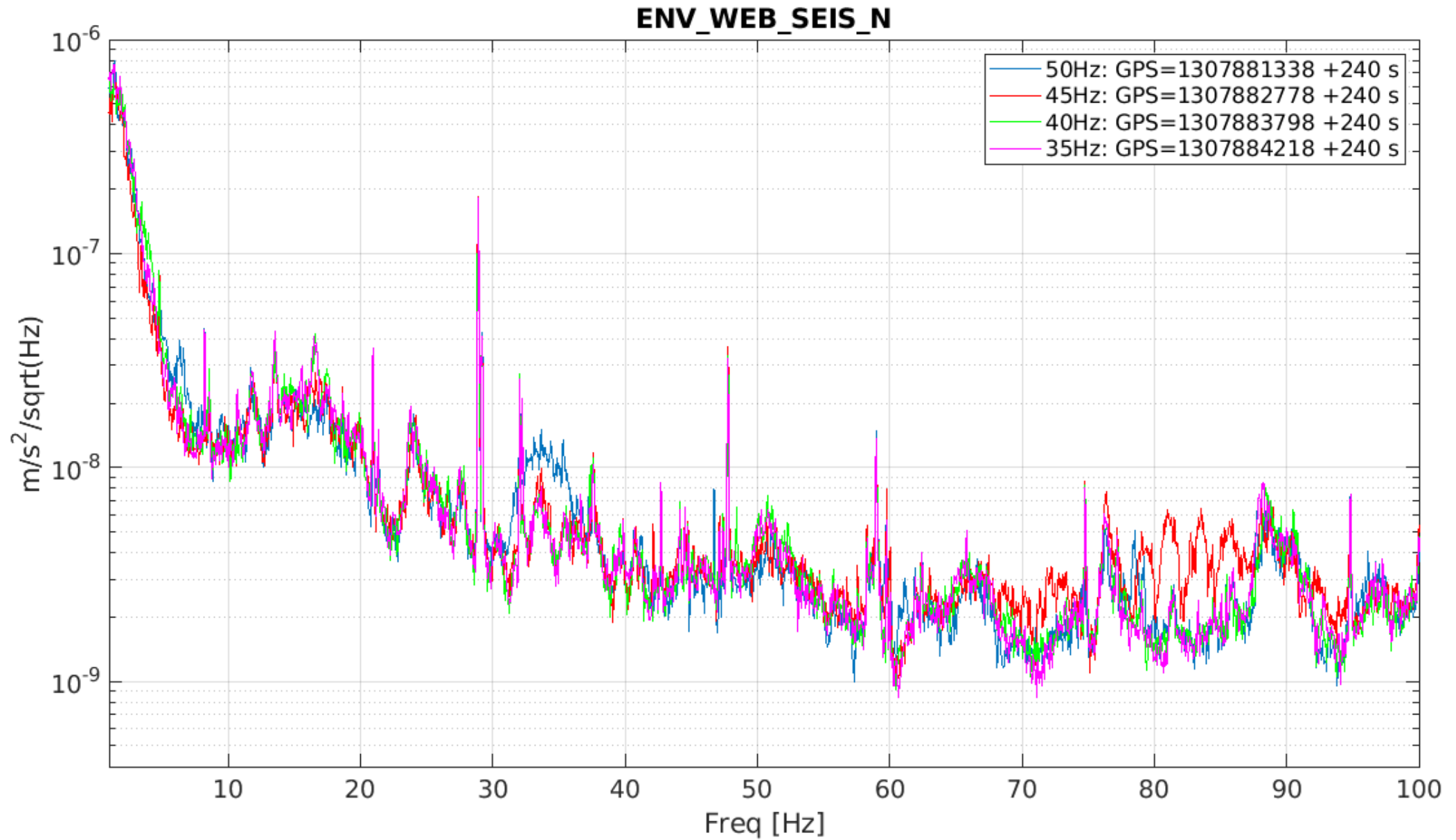
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

# Guralp seismometer

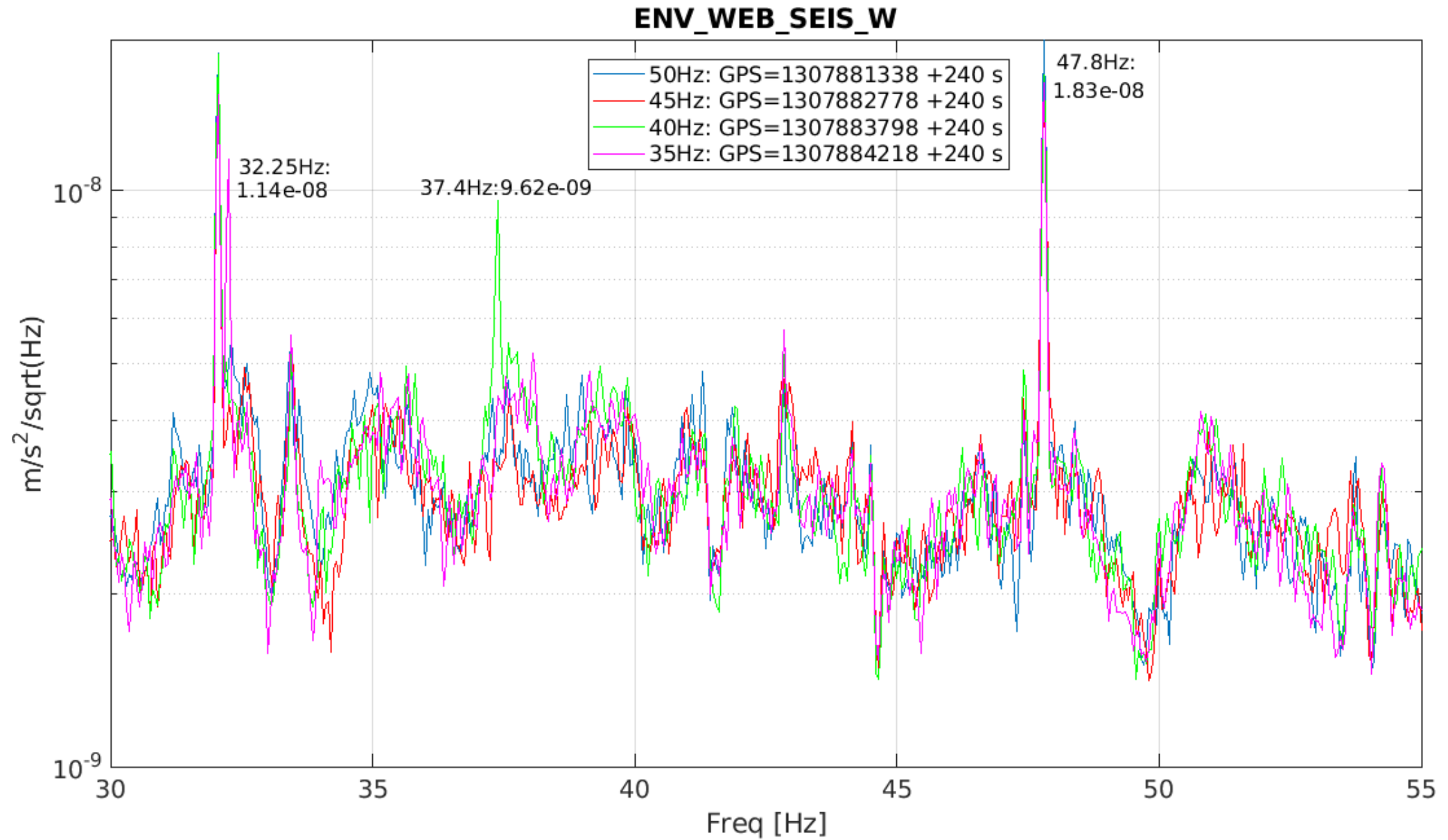




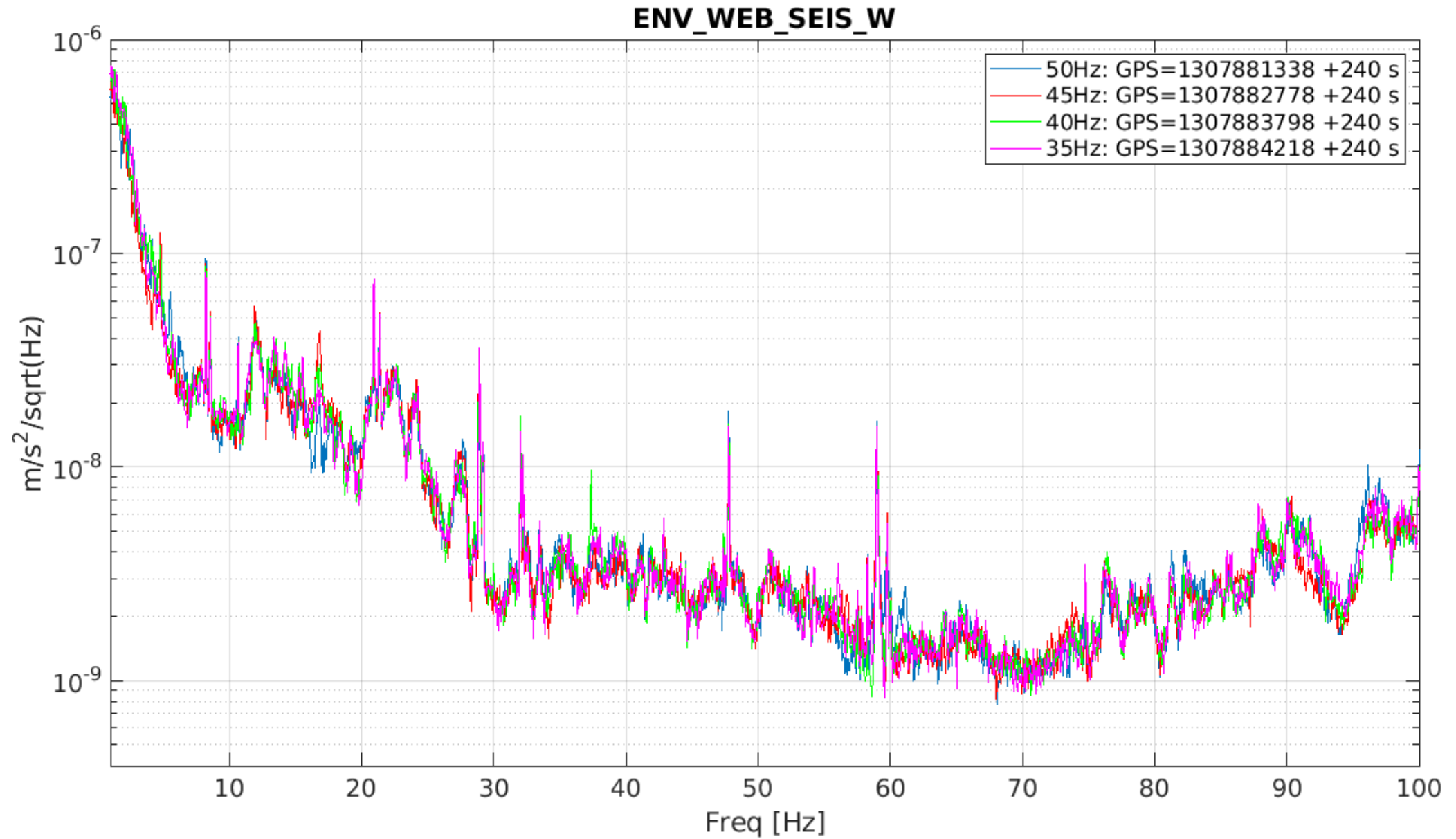
# Guralp seismometer



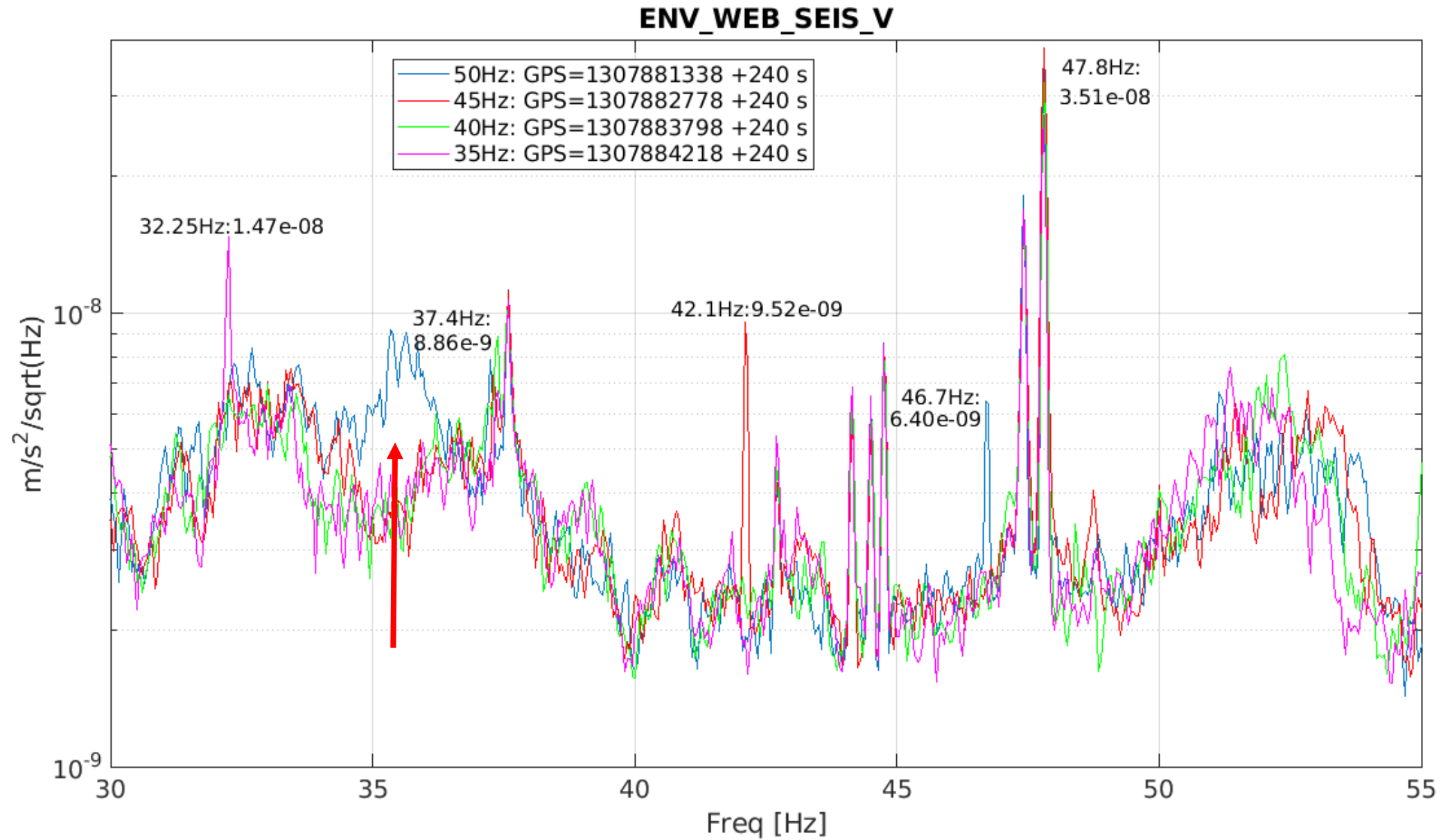
# Guralp seismometer



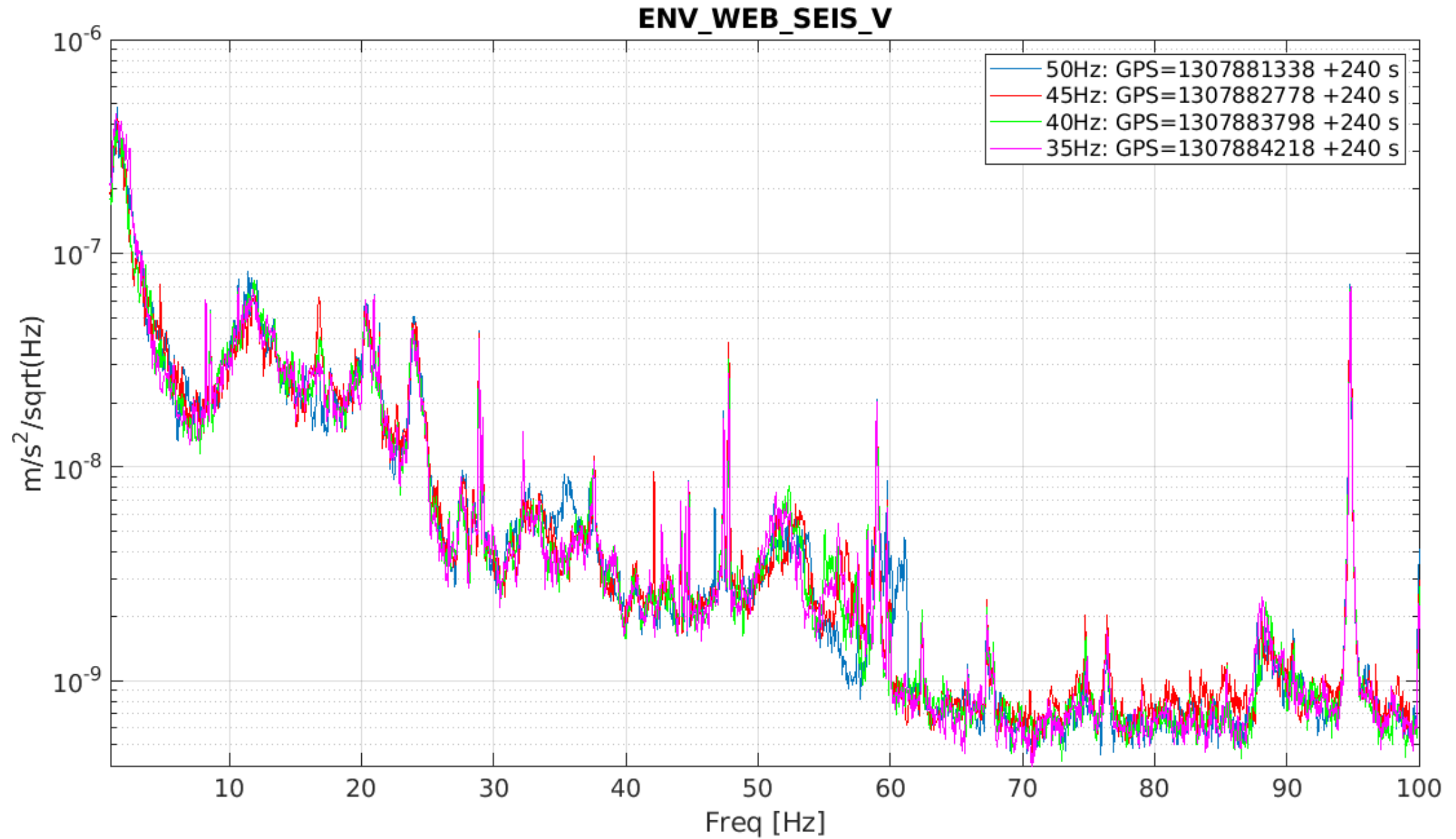
# Guralp seismometer



# Guralp seismometer



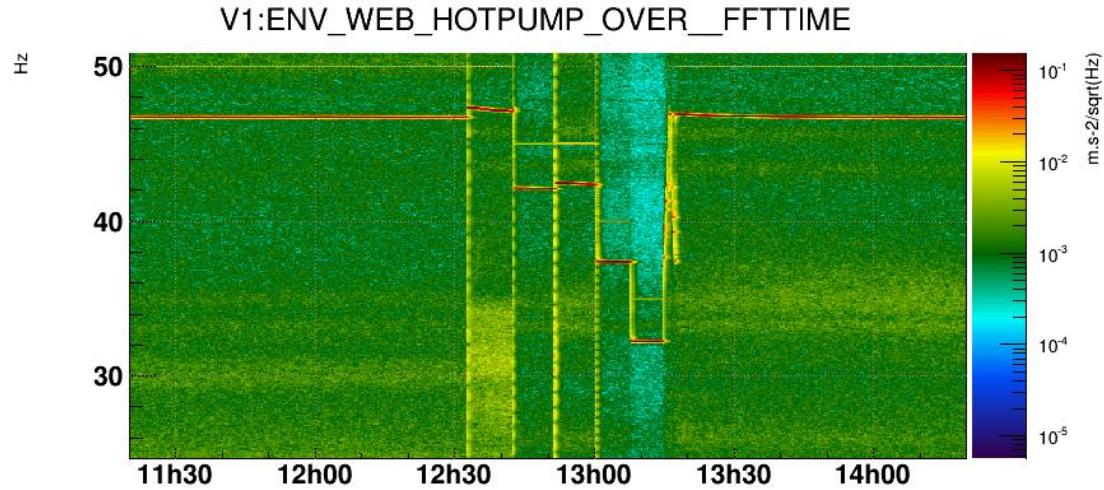
# Guralp seismometer



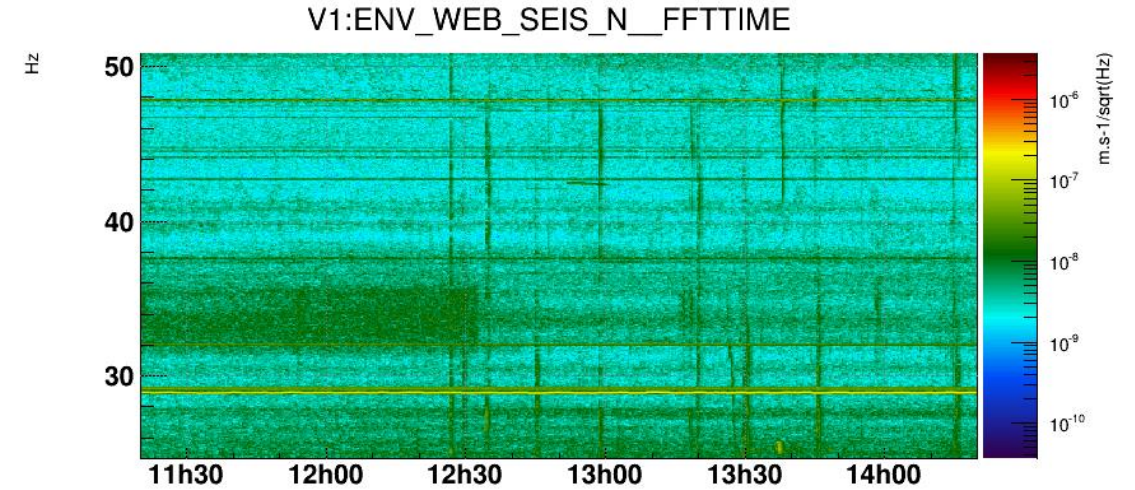


# Guralp seismometer

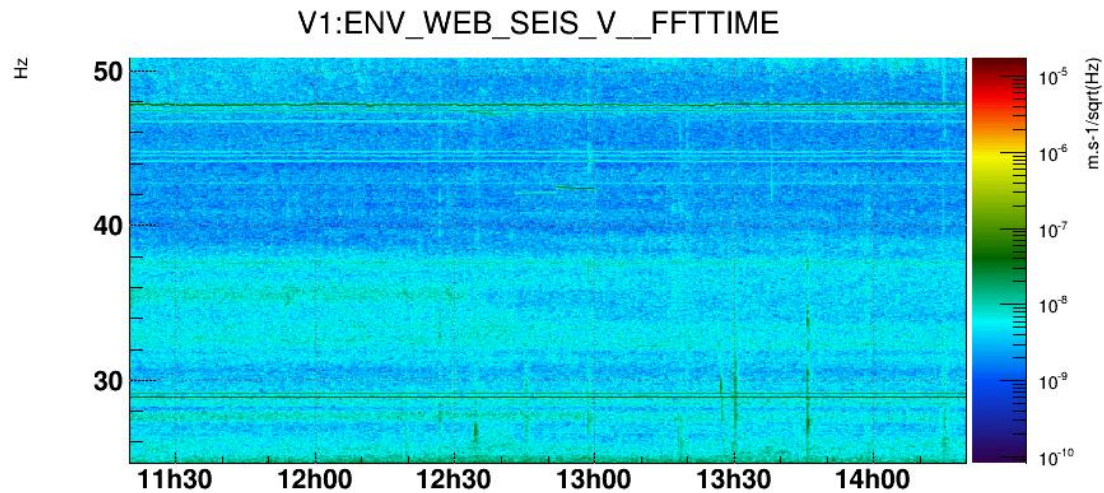
dataDisplay v10r9p2 : started by pierini on Jun 22 2021 09:29:35 UTC



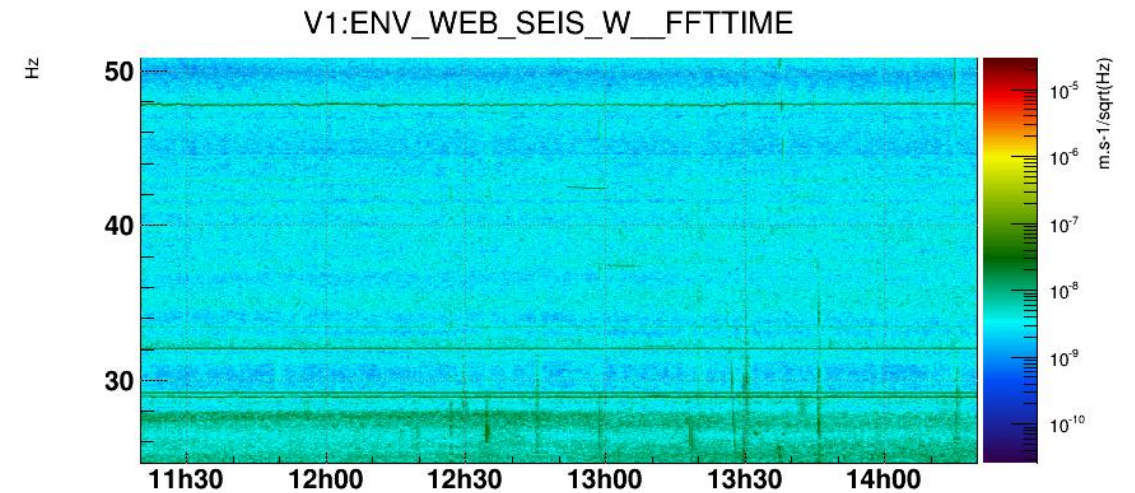
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1307877618.00 : Jun 16 2021 11:20:00 UTC dt:20.00s nAv:2



1307877618.00 : Jun 16 2021 11:20:00 UTC dt:20.00s nAv:2

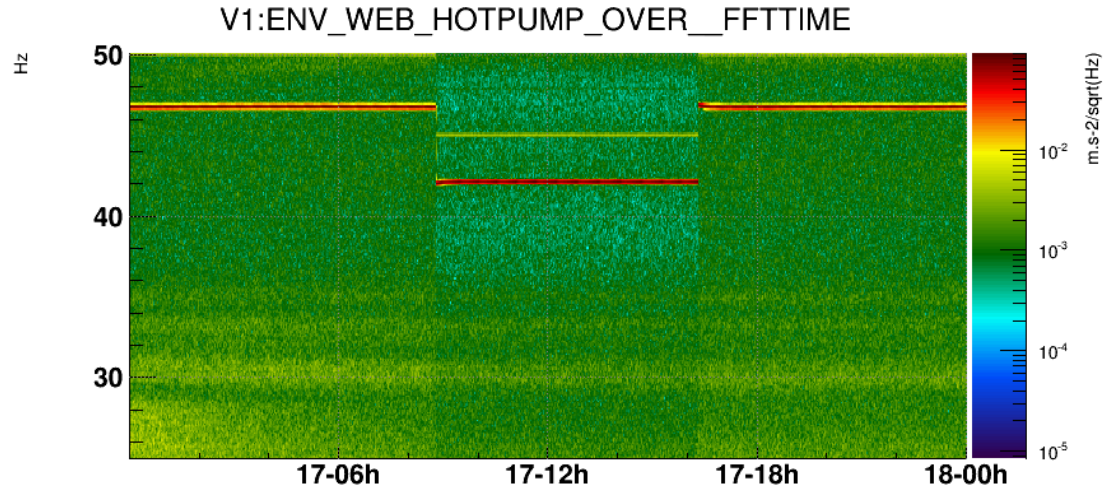


1307877618.00 : Jun 16 2021 11:20:00 UTC dt:20.00s nAv:2

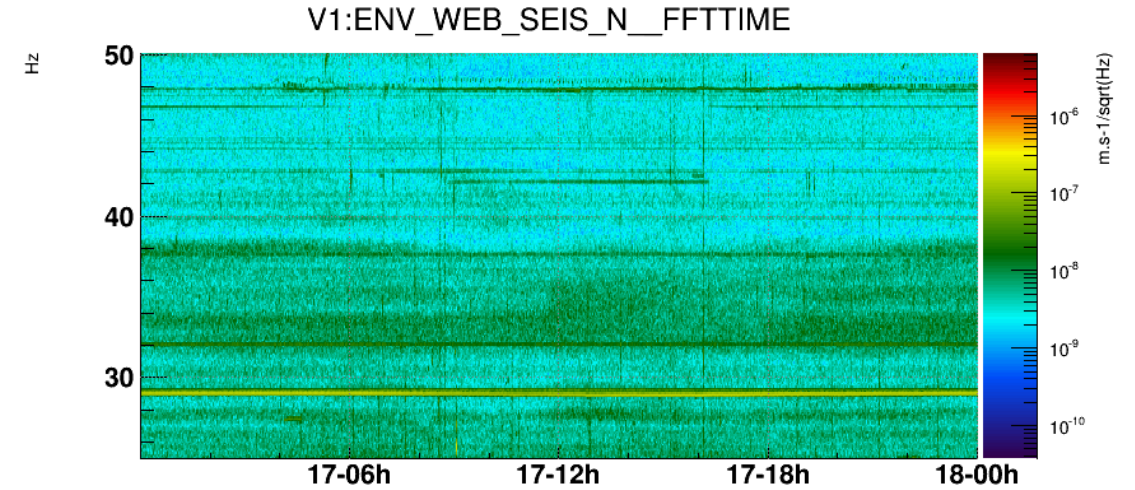


# Guralp seismometer

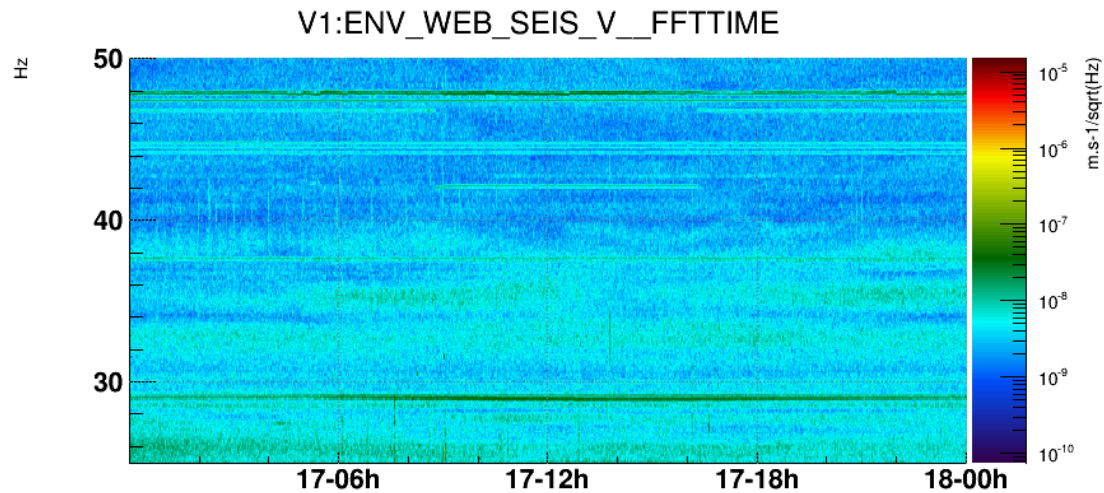
dataDisplay v10r9p2 : started by pierini on Jun 22 2021 09:51:41 UTC



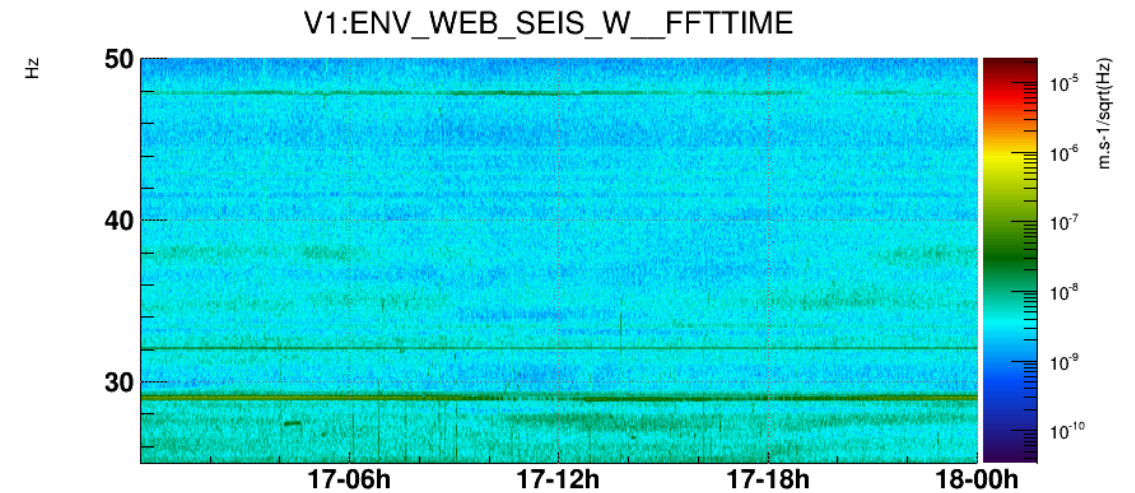
1307923238.00 : Jun 17 2021 00:00:20 UTC dt:10.00s nAv:2



1307923238.00 : Jun 17 2021 00:00:20 UTC dt:10.00s nAv:2



1307923238.00 : Jun 17 2021 00:00:20 UTC dt:10.00s nAv:2



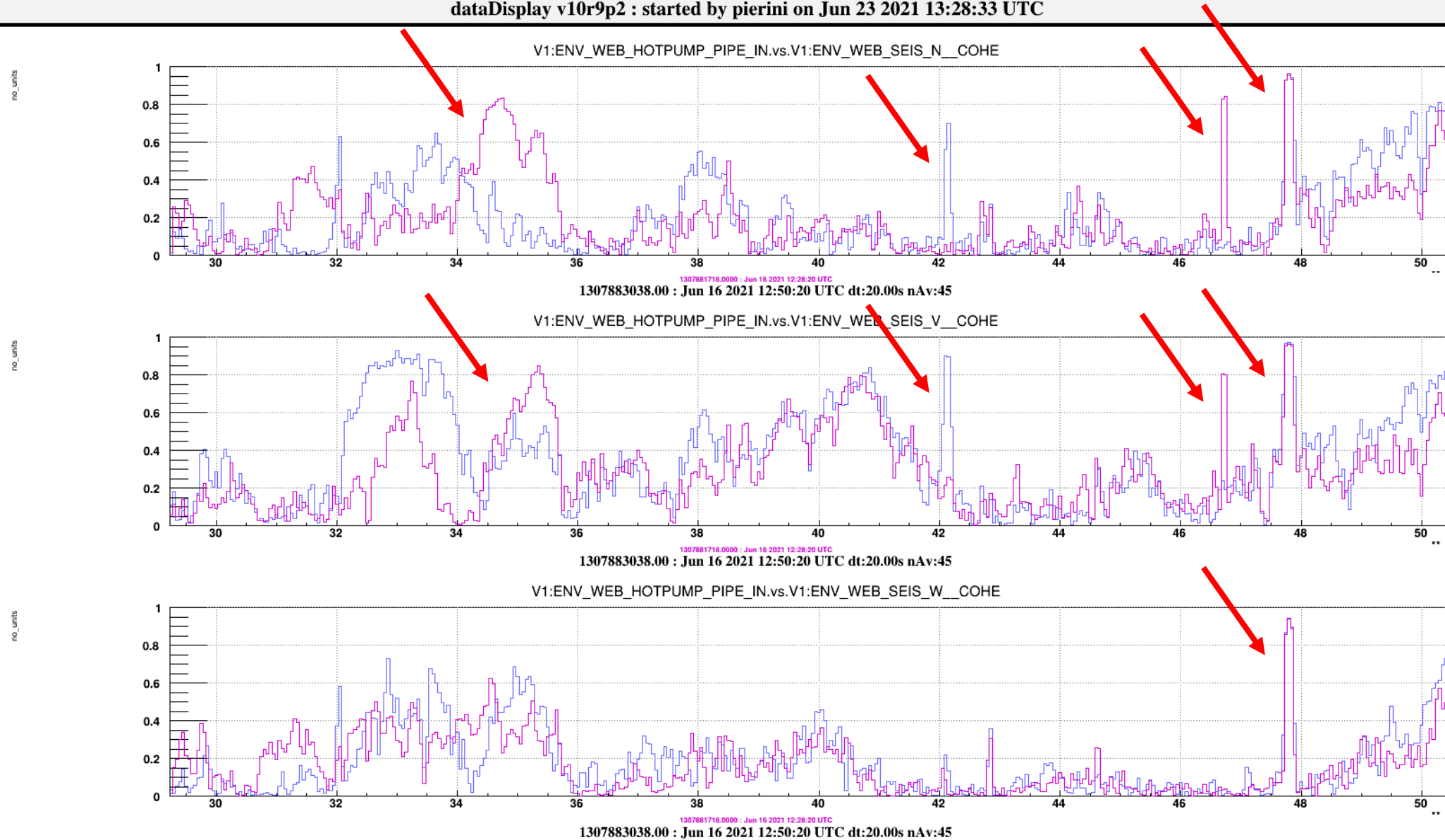
1307923238.00 : Jun 17 2021 00:00:20 UTC dt:10.00s nAv:2

# Guralp seismometer

Coherence with ENV\_WEB\_HOTPUMP\_PIPE\_IN

dataDisplay v10r9p2 : started by pierini on Jun 23 2021 13:28:33 UTC

Purple: hot pump at 50Hz  
Blue: hot pump at 45Hz

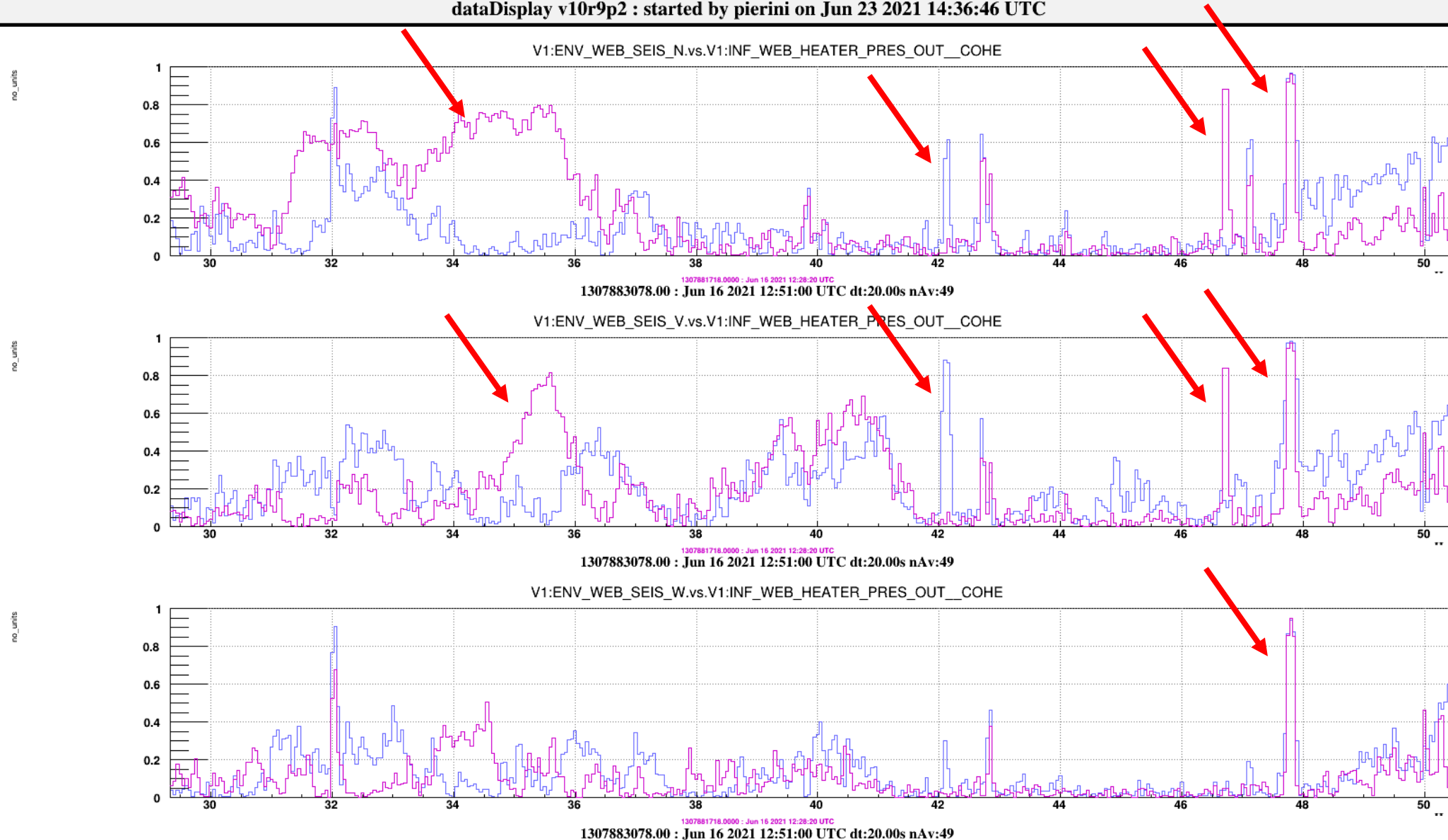


# Guralp seismometer

Coherence with INF\_WEB\_HEATER\_PRES\_OUT

dataDisplay v10r9p2 : started by pierini on Jun 23 2021 14:36:46 UTC

Purple: hot pump at 50Hz  
Blue: hot pump at 45Hz

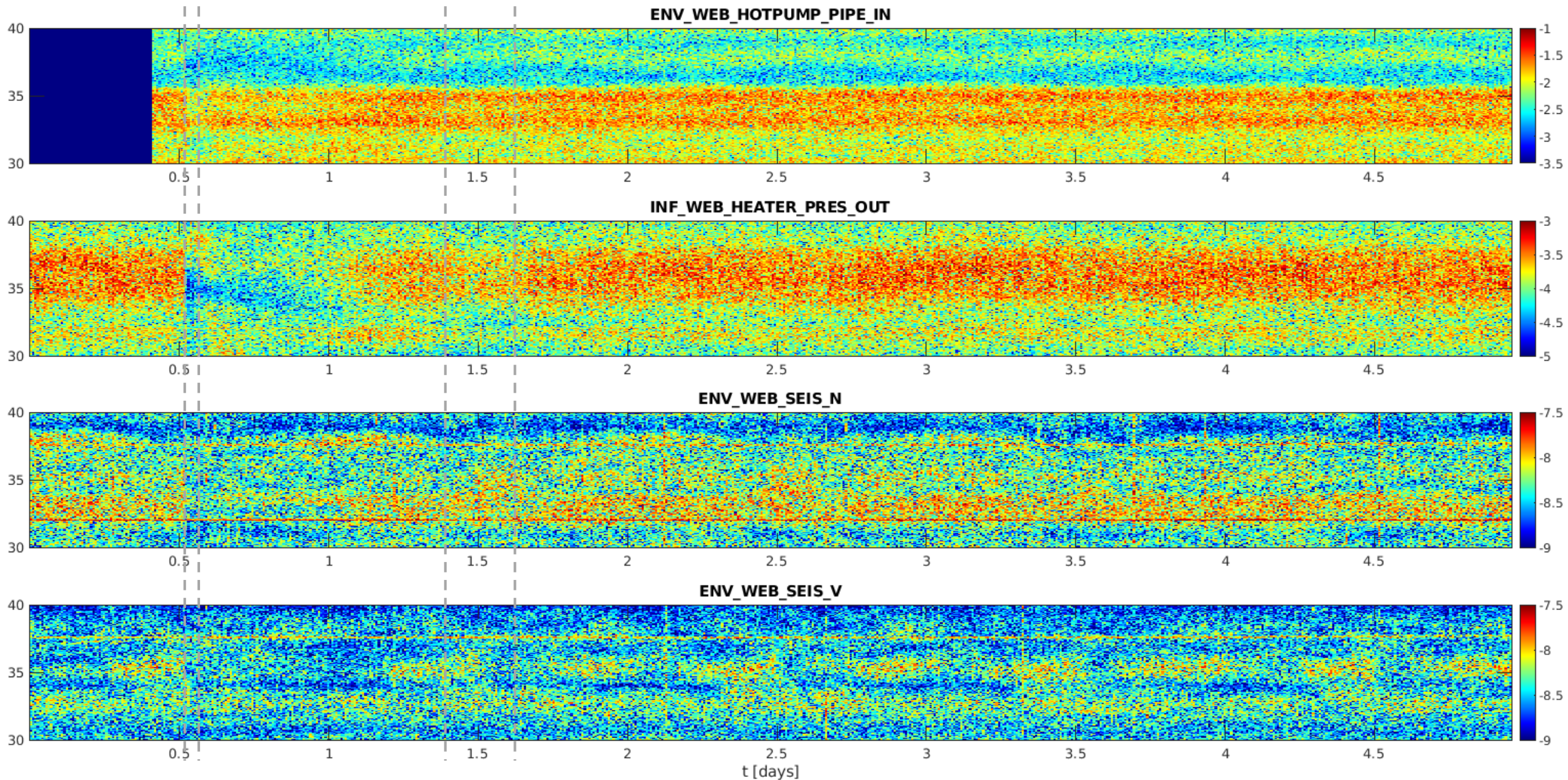




# Guralp seismometer

Day 0: slowdown operations  
Day 1: long slowdown

Zoomed spectrograms, 5 days

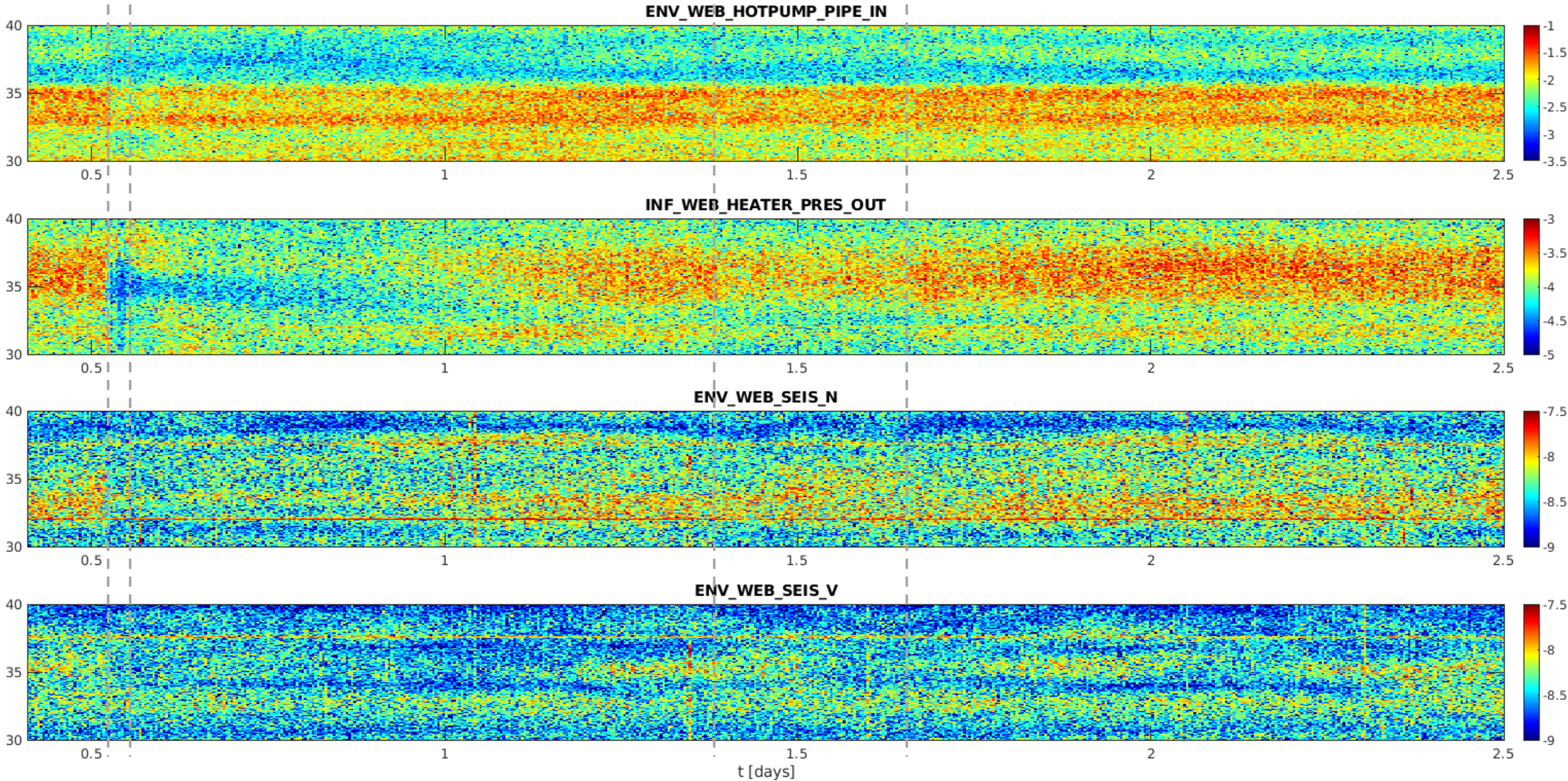




# Guralp seismometer

Day 0: slowdown operations  
Day 1: long slowdown

Zoomed spectrograms, 2.5 days

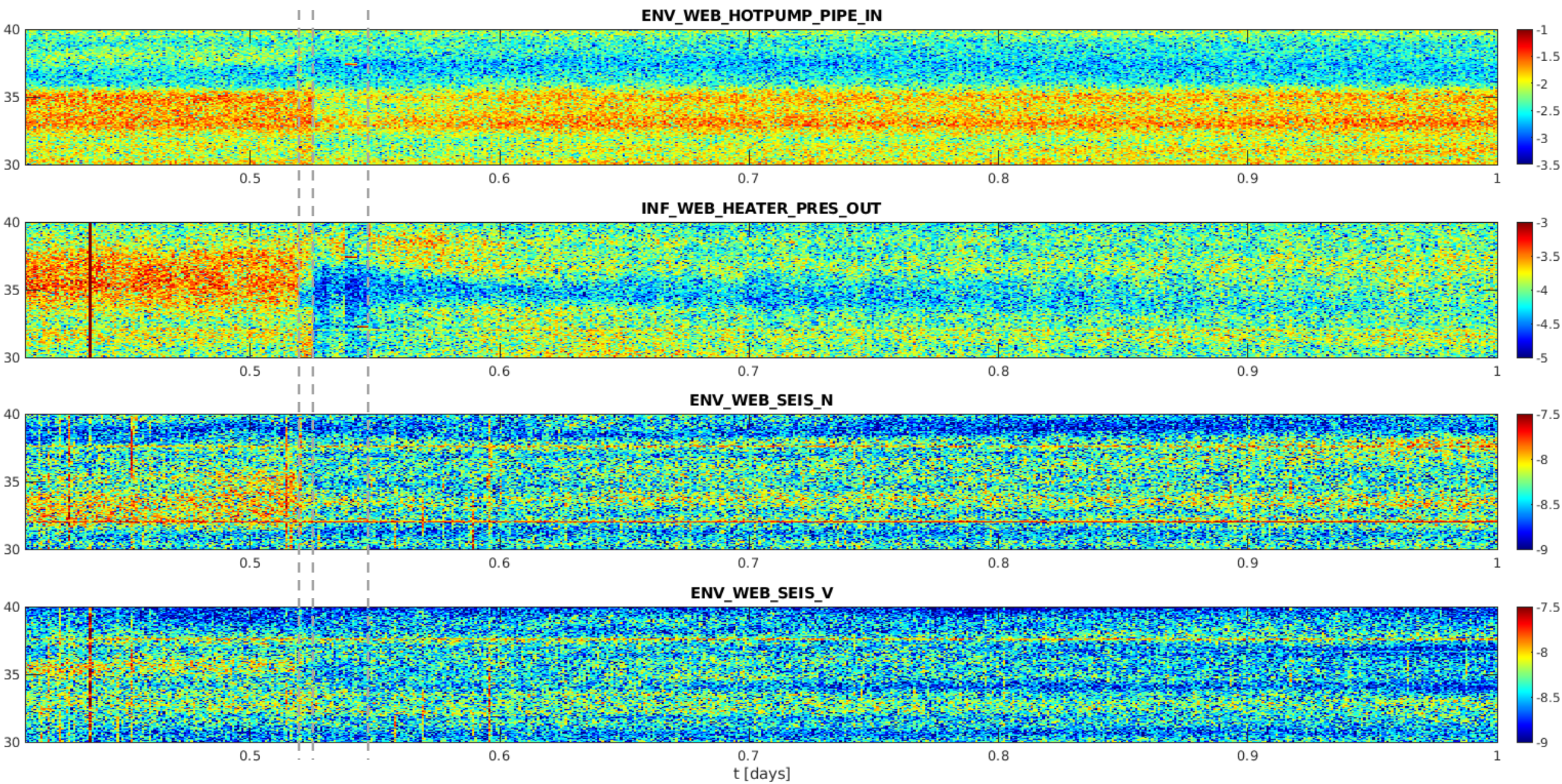




# Guralp seismometer

Day 0: slowdown operations  
Day 1: long slowdown

Zoomed spectrograms, 1 day

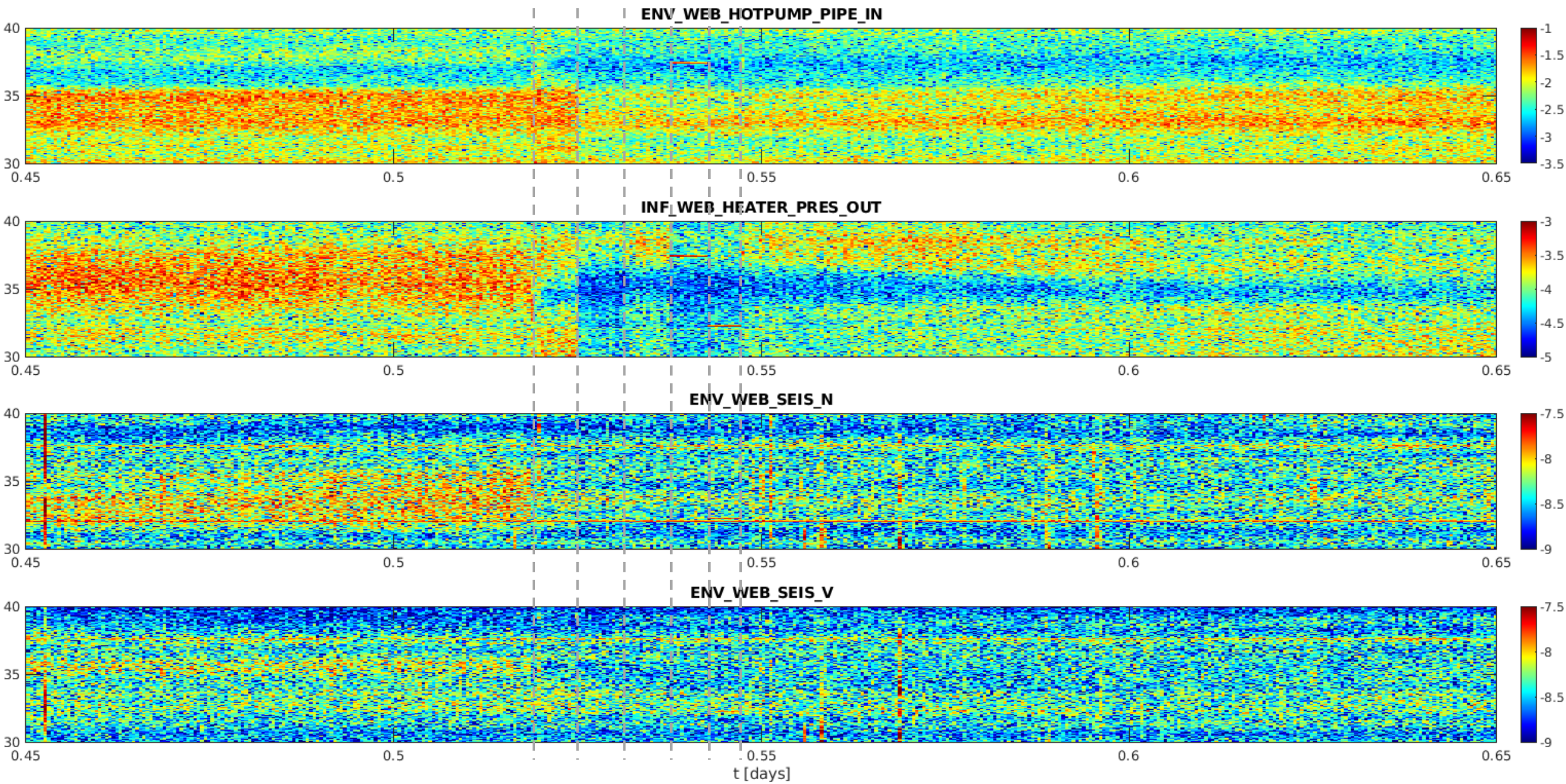




# Guralp seismometer

Day 0: slowdown operations  
Day 1: long slowdown

Zoomed spectrograms, 5 hh



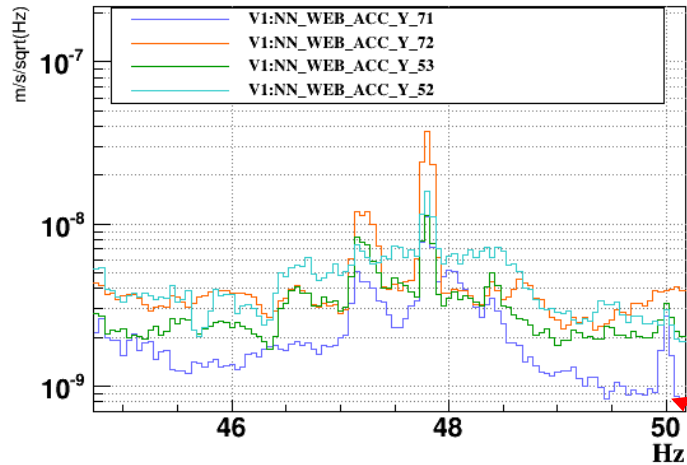
# Guralp seismometer

- The narrow vibration line clearly enters the WEB platform
- There is a large frequency region around 35Hz that seems to depend on the water pumps in some indirect way:
  - The noise bump disappears when we switched from right to left pump and slowed down the supply.
  - The same noise bump does not come back immediately after the system is restored to the original configuration: it takes up to 1-2 days to grow.
  - There is an high coherence in this frequency region between the pipes flux sensors and the WEB seismometer, which disappears when we start the switch/slowdown operations.

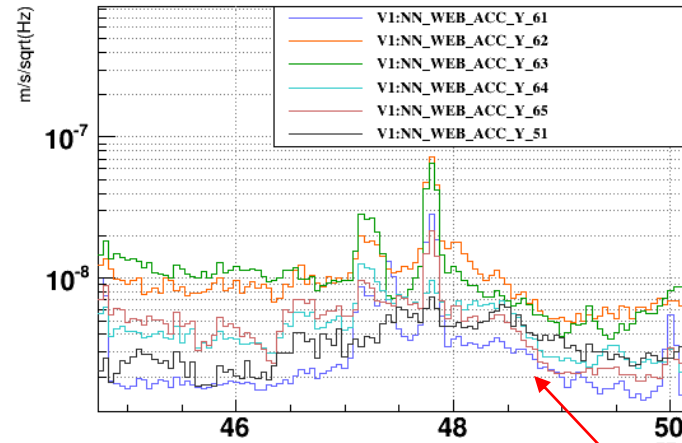


# Newtonian sensors

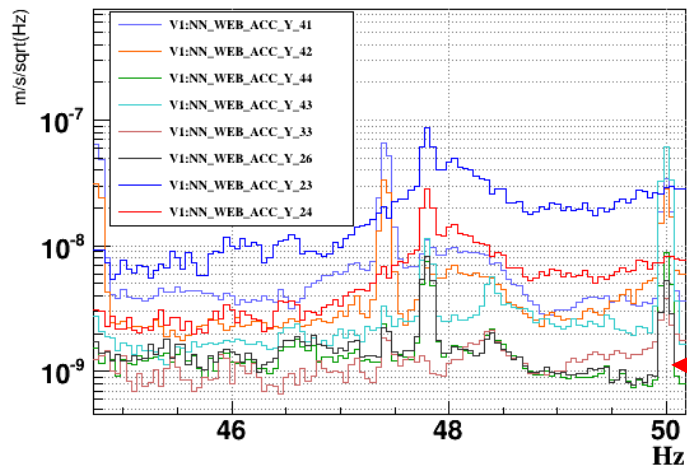
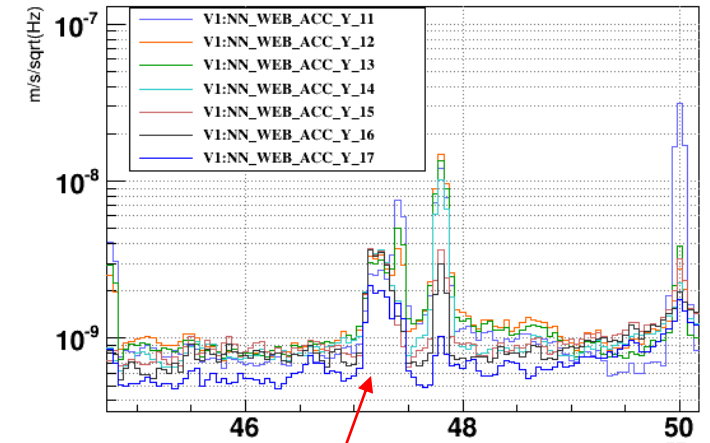
dataDisplay v10r9p2 : started by pierini on Jun 18 2021 14:58:54 UTC



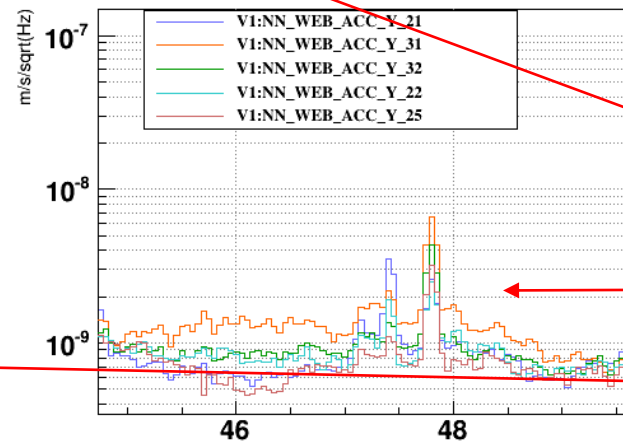
1307882508.00 : Jun 16 2021 12:41:30 UTC dt:20.00s nAv:48



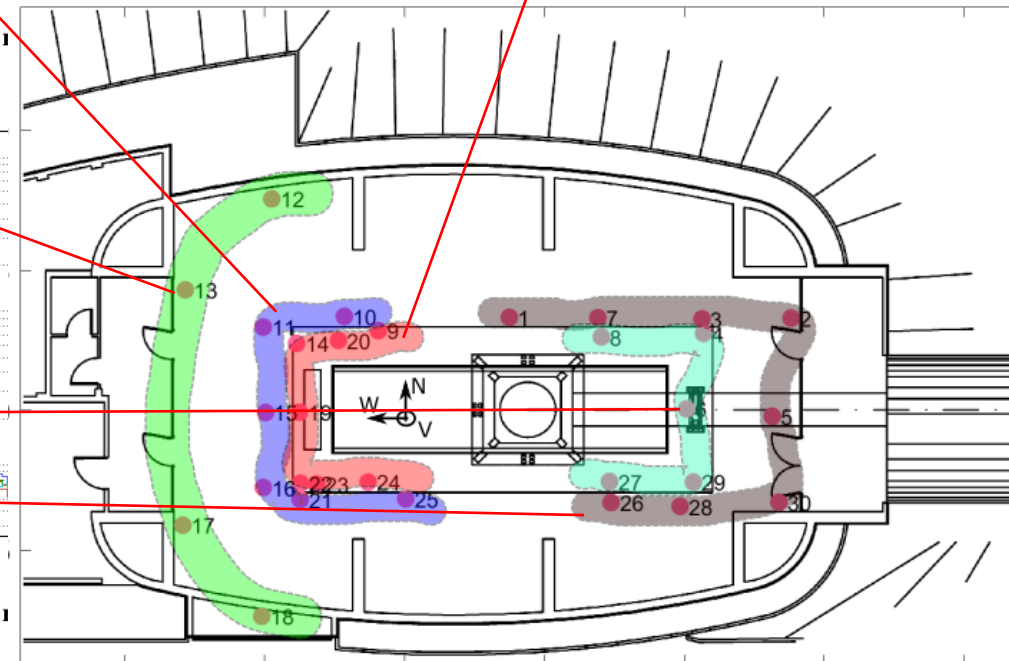
1307882508.00 : Jun 16 2021 12:41:30 UTC dt:20.00s



1307882508.00 : Jun 16 2021 12:41:30 UTC dt:20.00s nAv:48

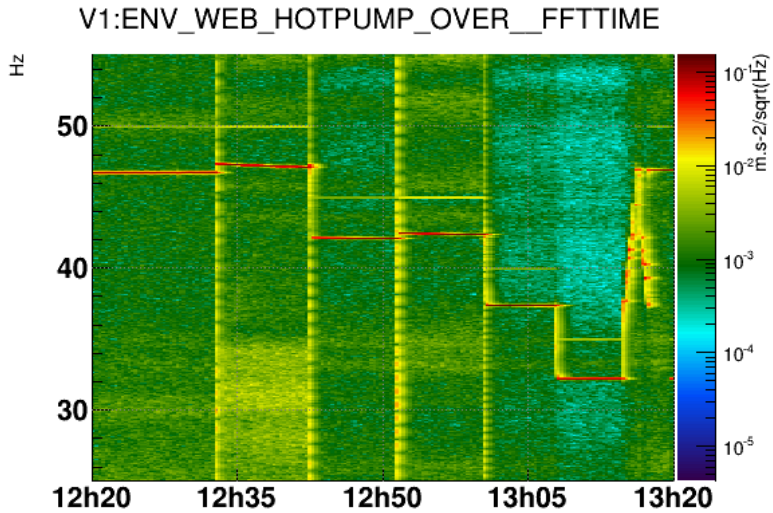


1307882508.00 : Jun 16 2021 12:41:30 UTC dt:20.00s

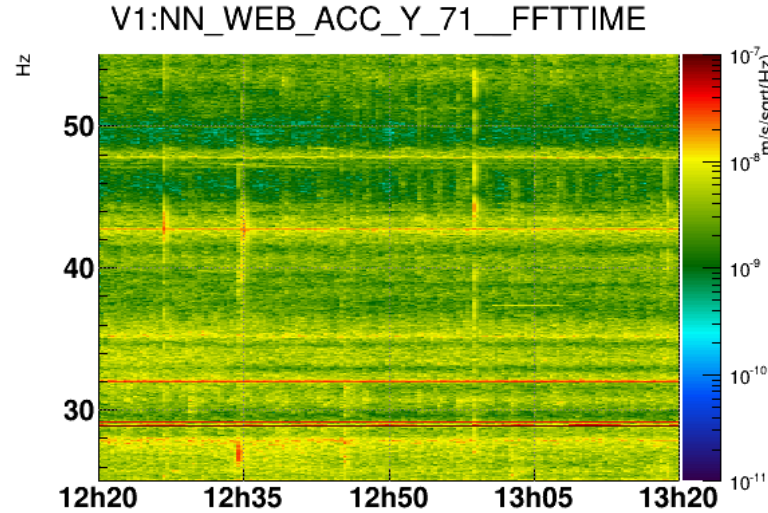


# Newtonian sensors

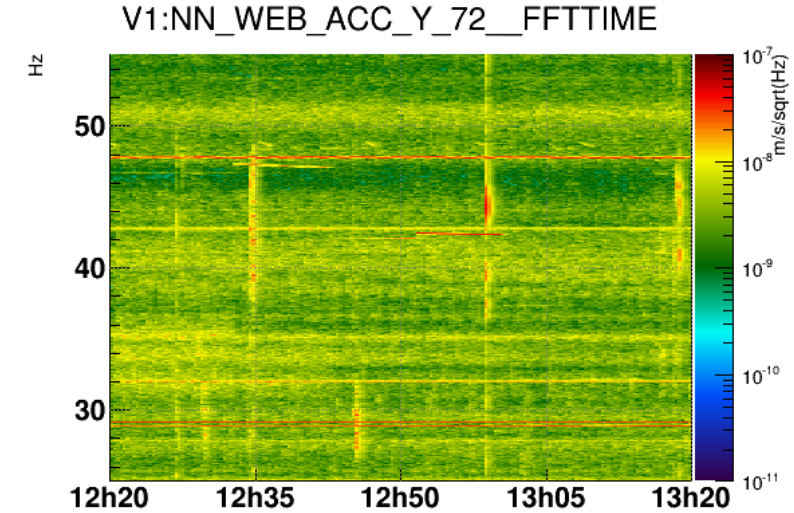
dataDisplay v10r9p2 : started by pierini on Jun 18 2021 11:01:40 UTC



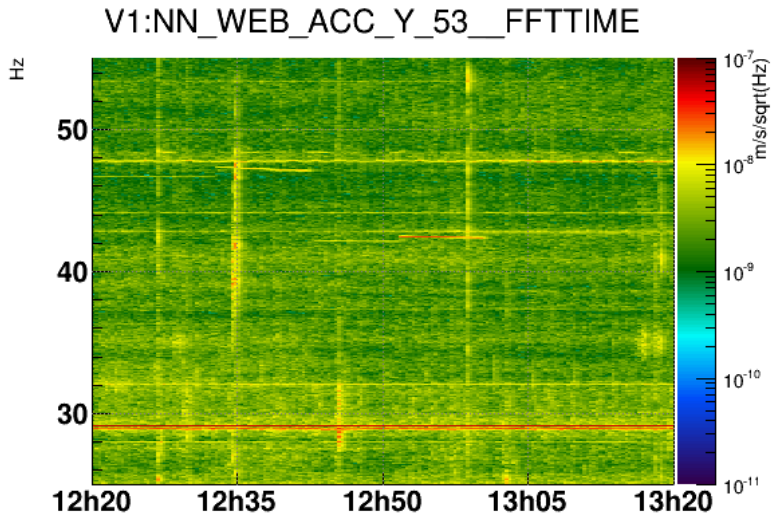
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



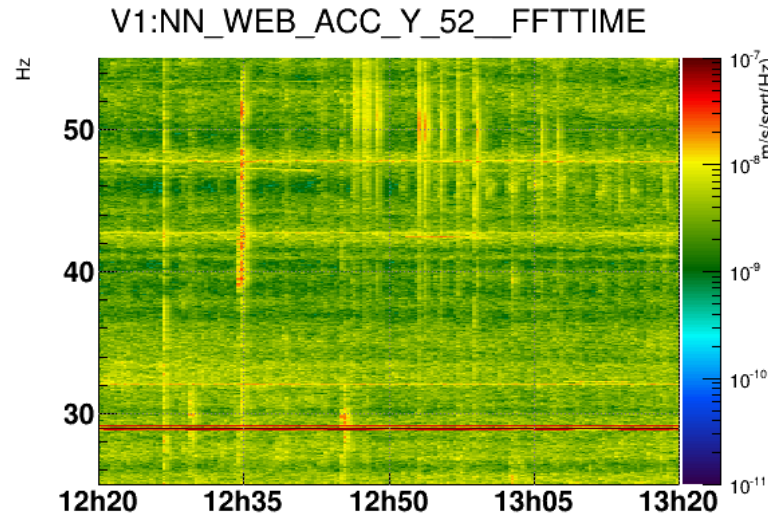
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



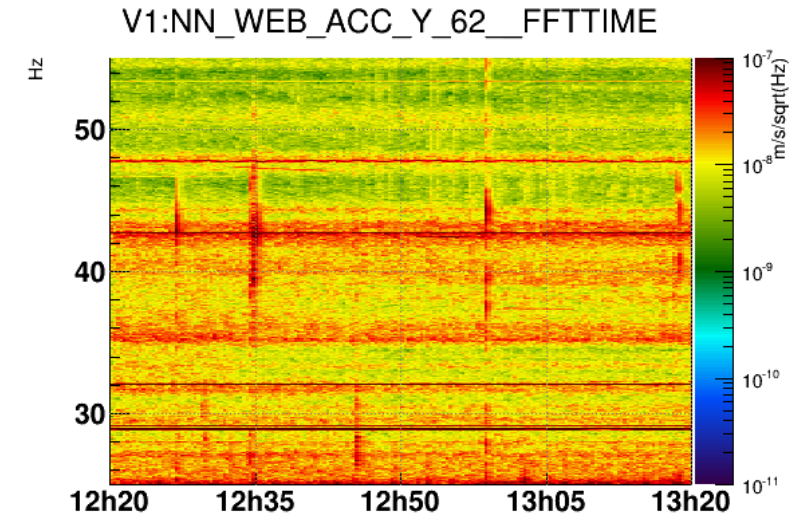
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

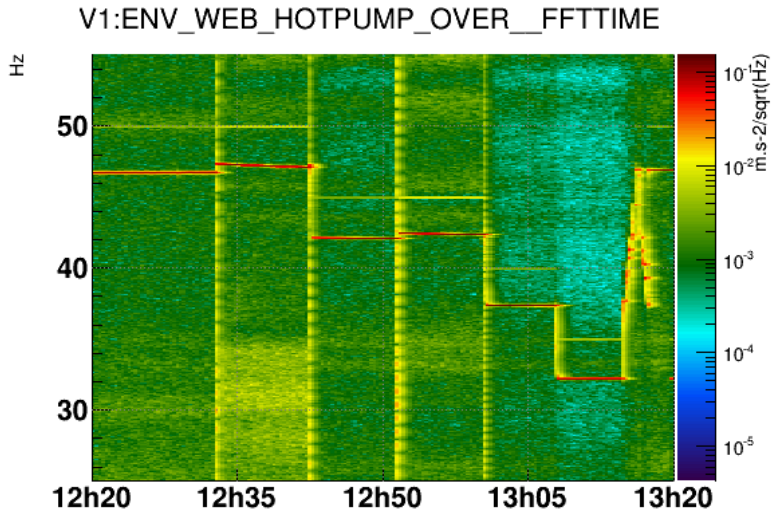


1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

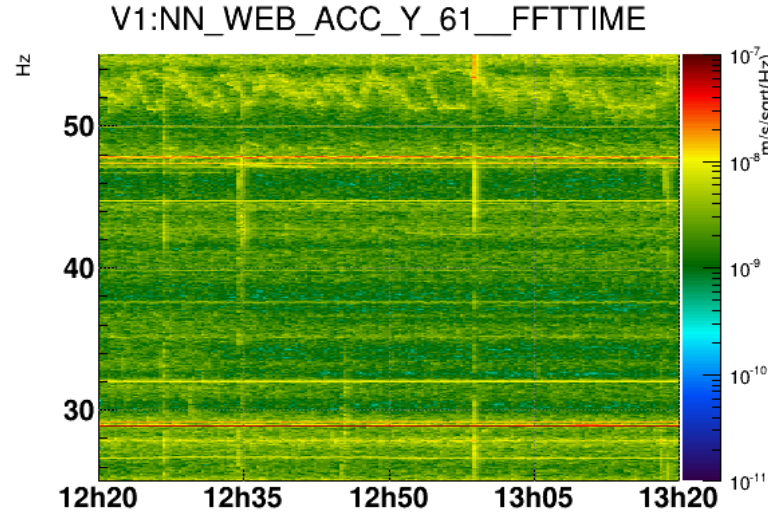


# Newtonian sensors

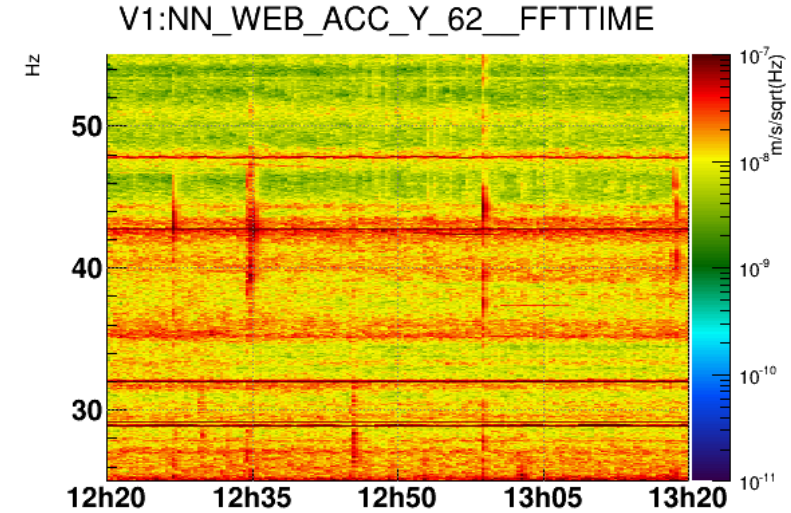
dataDisplay v10r9p2 : started by pierini on Jun 18 2021 11:11:23 UTC



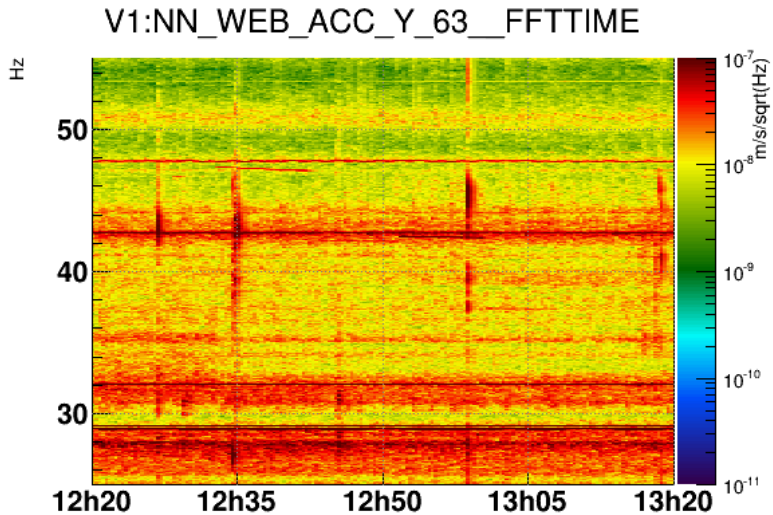
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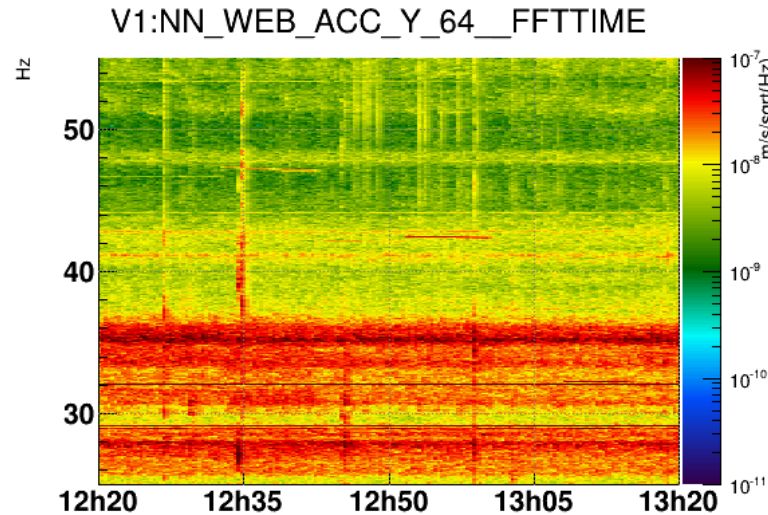
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



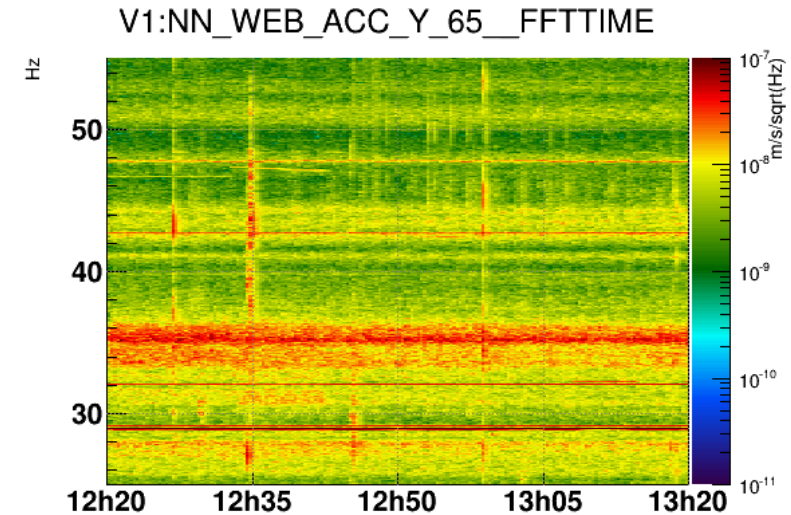
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



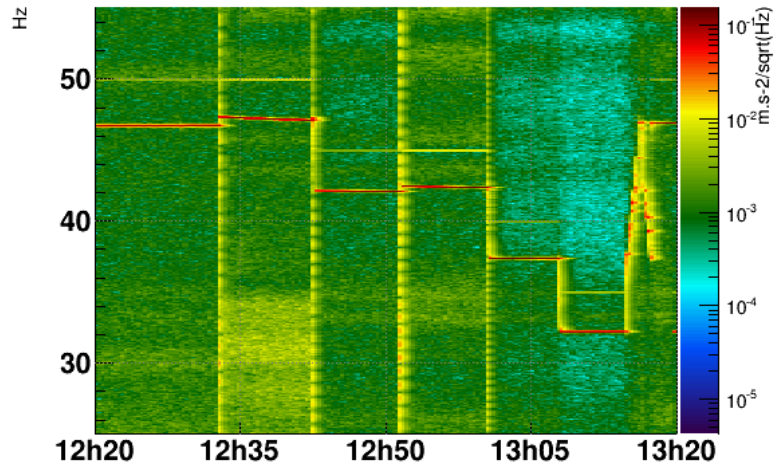
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



# Newtonian sensors

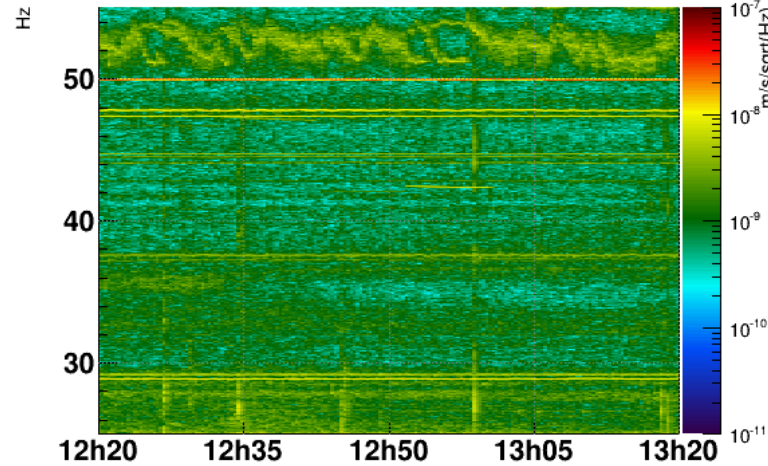
dataDisplay v10r9p2 : started by pierini on Jun 18 2021 11:18:32 UTC

V1:ENV\_WEB\_HOTPUMP\_OVER\_\_FFTTIME



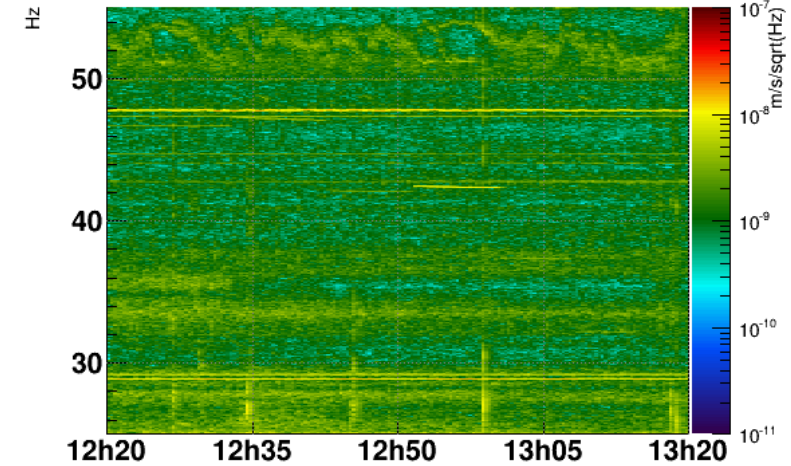
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

V1:NN\_WEB\_ACC\_Y\_11\_\_FFTTIME



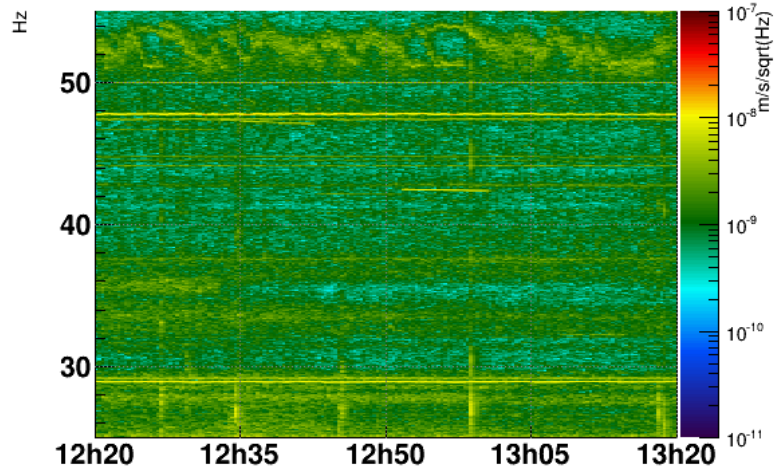
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

V1:NN\_WEB\_ACC\_Y\_12\_\_FFTTIME



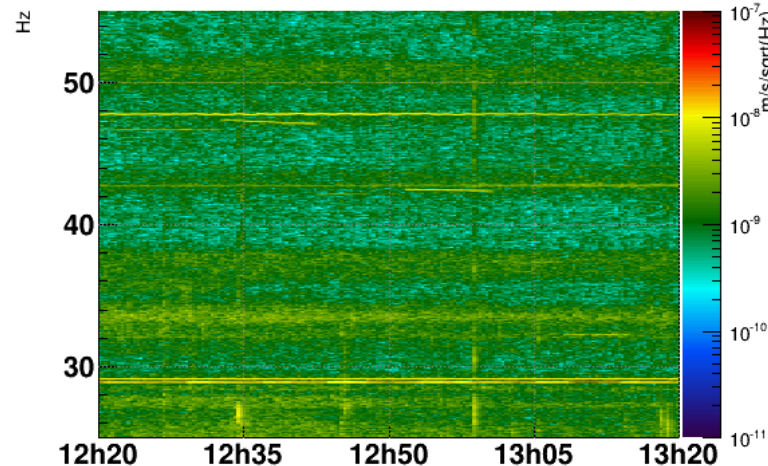
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

V1:NN\_WEB\_ACC\_Y\_13\_\_FFTTIME



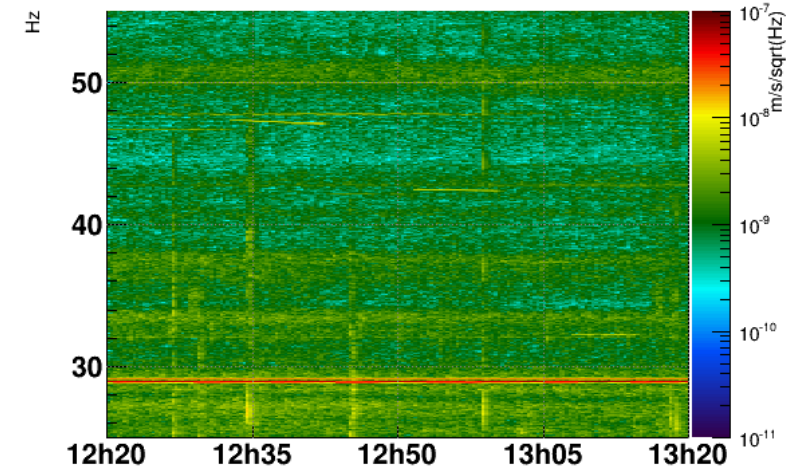
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

V1:NN\_WEB\_ACC\_Y\_14\_\_FFTTIME



1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

V1:NN\_WEB\_ACC\_Y\_15\_\_FFTTIME



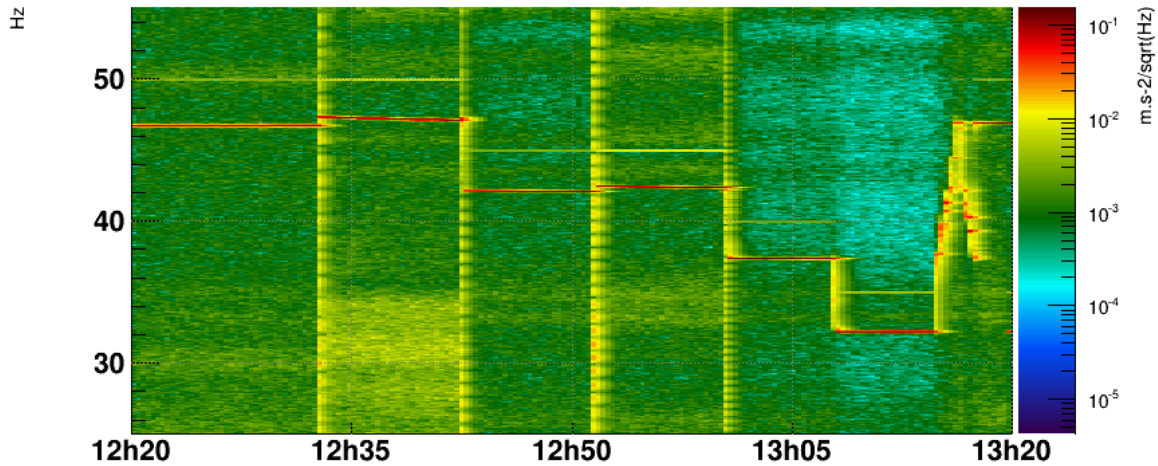
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



# Newtonian sensors

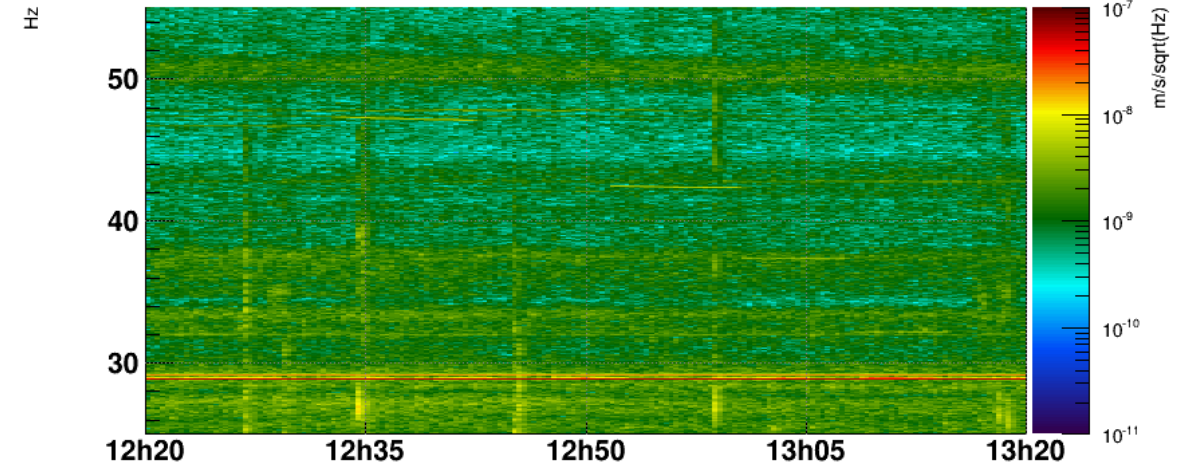
dataDisplay v10r9p2 : started by pierini on Jun 18 2021 12:37:49 UTC

V1:ENV\_WEB\_HOTPUMP\_OVER\_\_FFTTIME



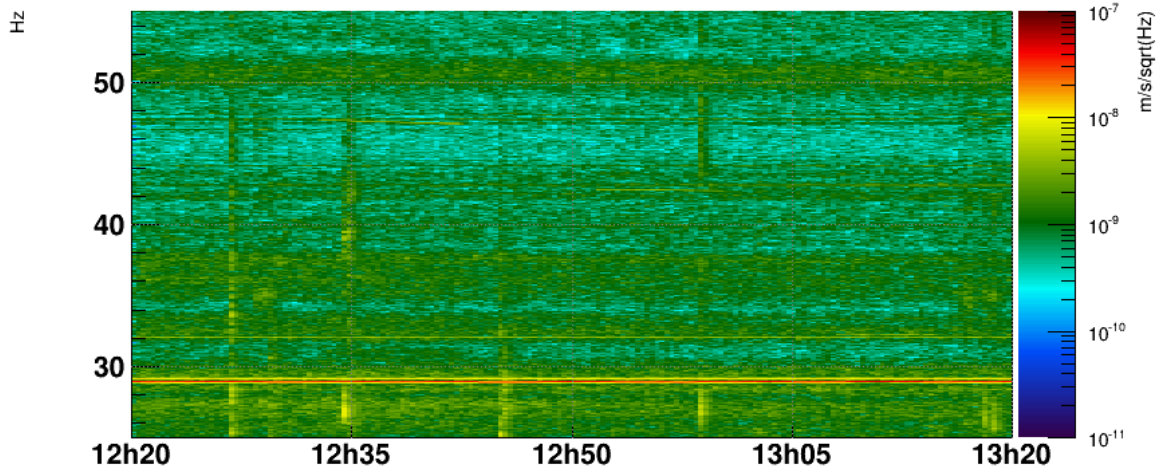
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

V1:NN\_WEB\_ACC\_Y\_16\_\_FFTTIME



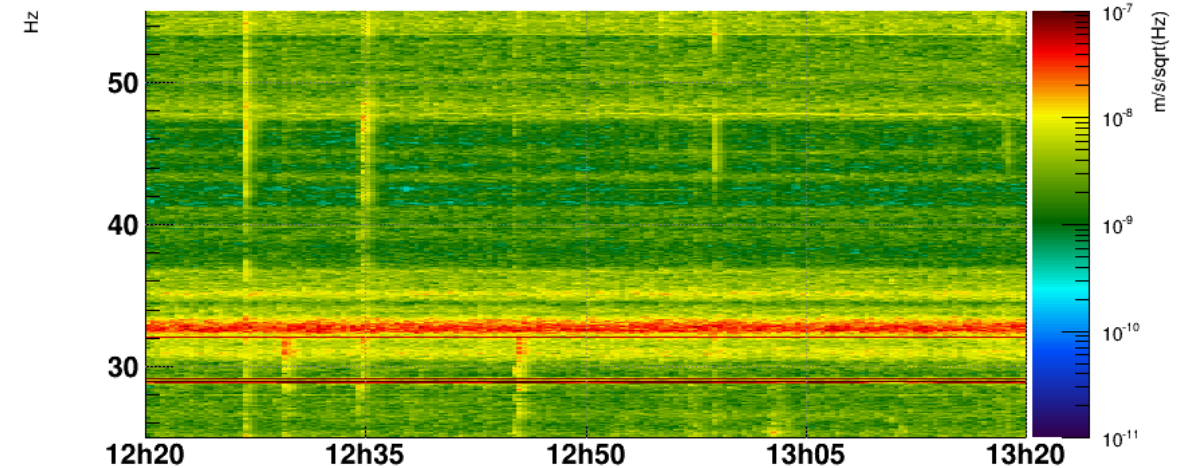
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

V1:NN\_WEB\_ACC\_Y\_17\_\_FFTTIME



1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

V1:NN\_WEB\_ACC\_Y\_51\_\_FFTTIME

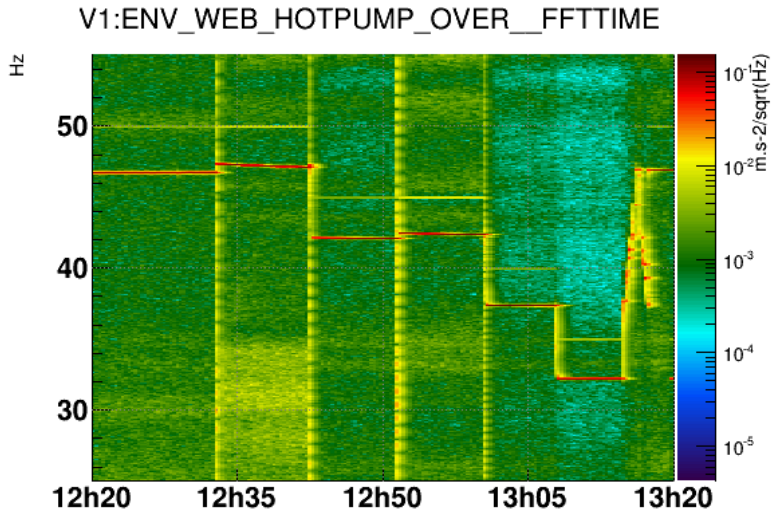


1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

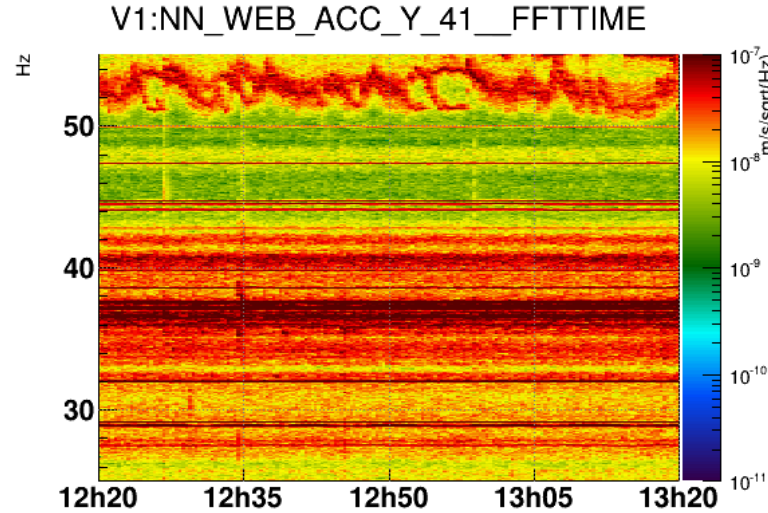


# Newtonian sensors

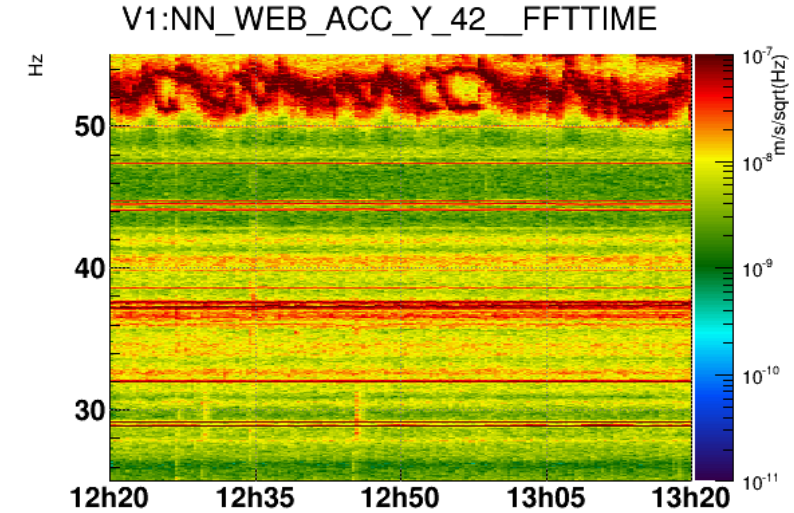
dataDisplay v10r9p2 : started by pierini on Jun 18 2021 12:26:13 UTC



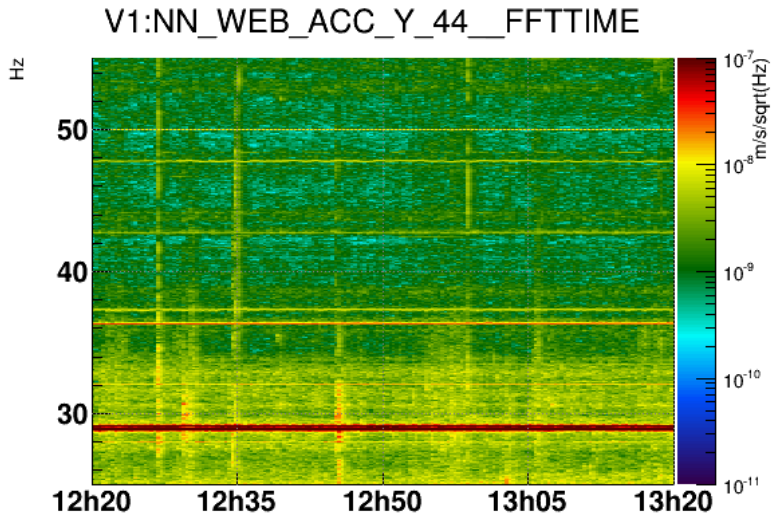
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



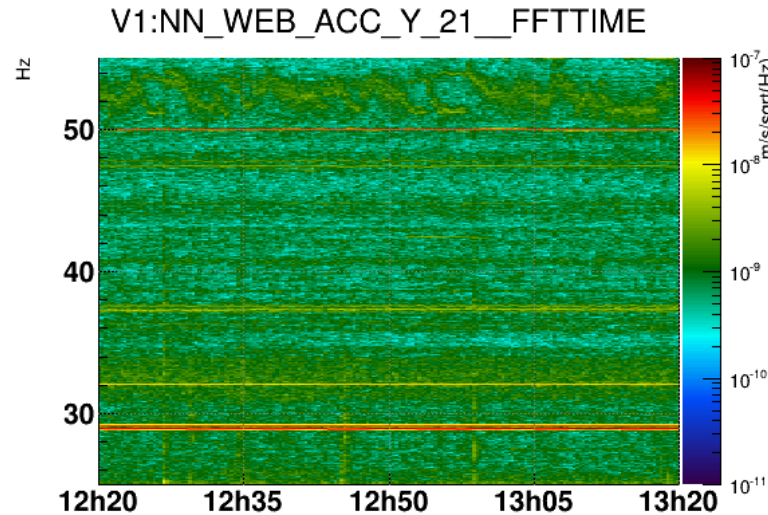
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



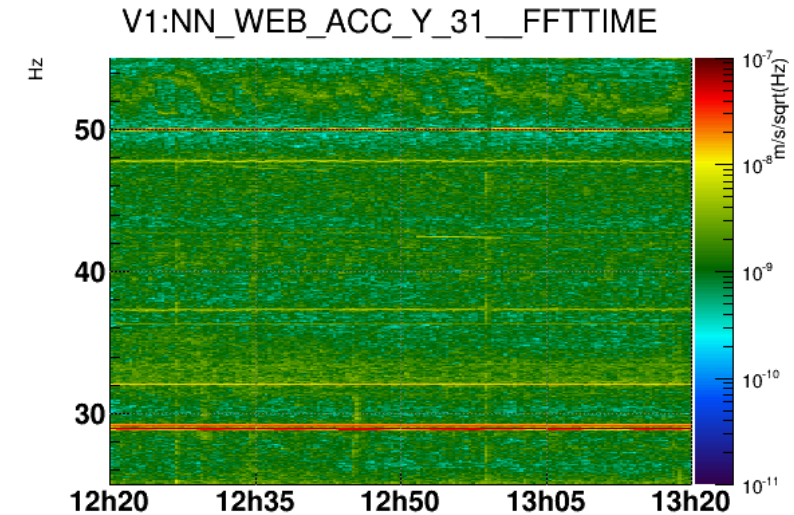
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

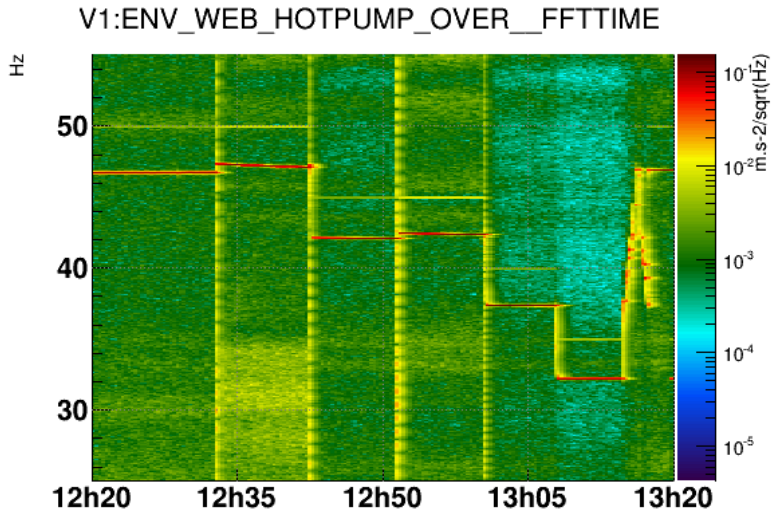


1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

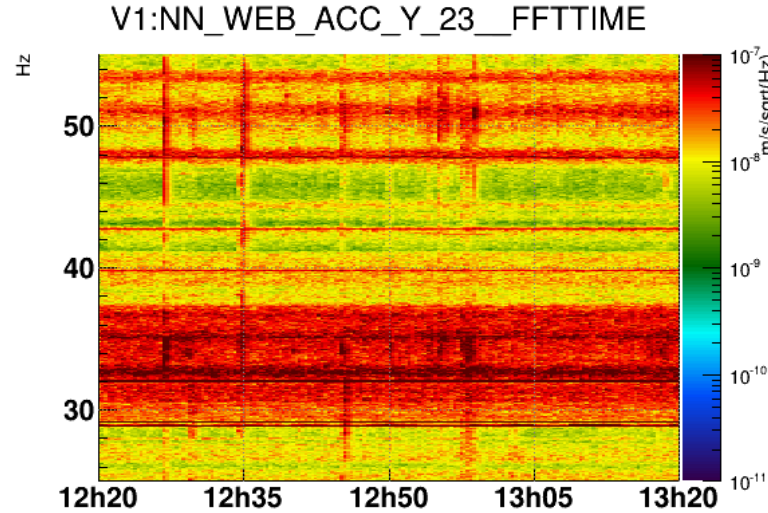


# Newtonian sensors

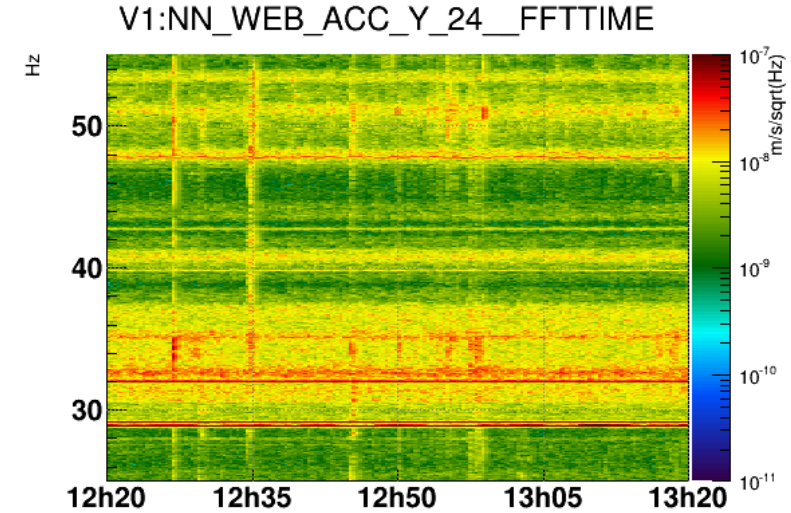
dataDisplay v10r9p2 : started by pierini on Jun 18 2021 12:47:21 UTC



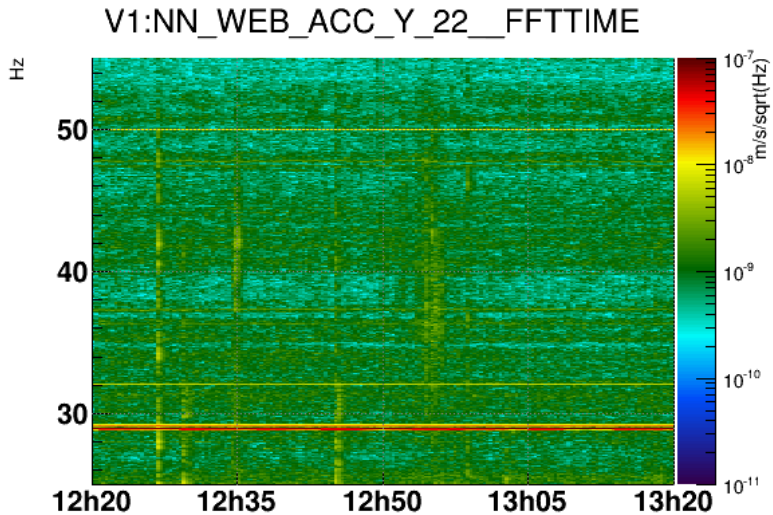
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



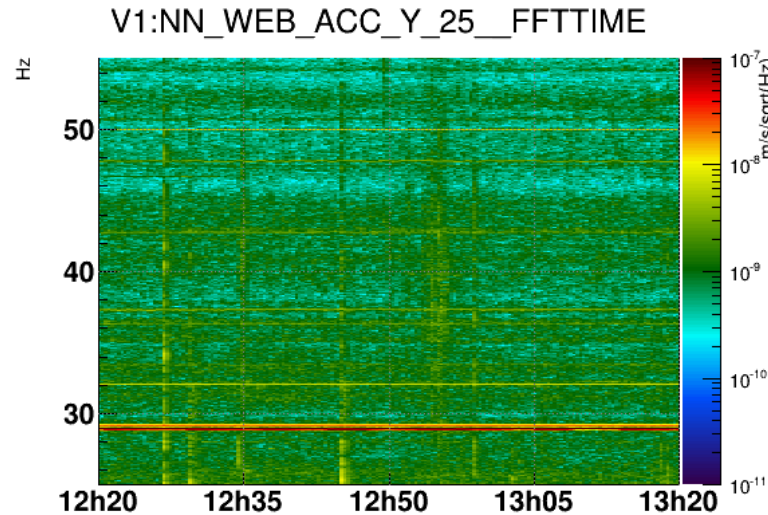
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

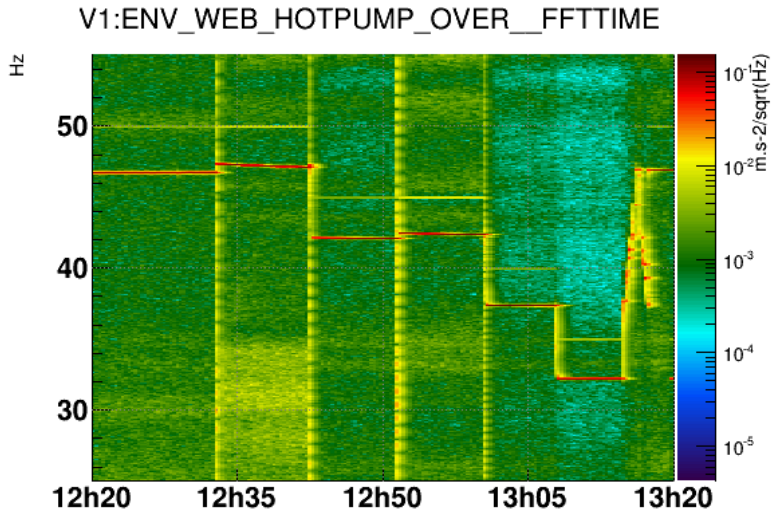


1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

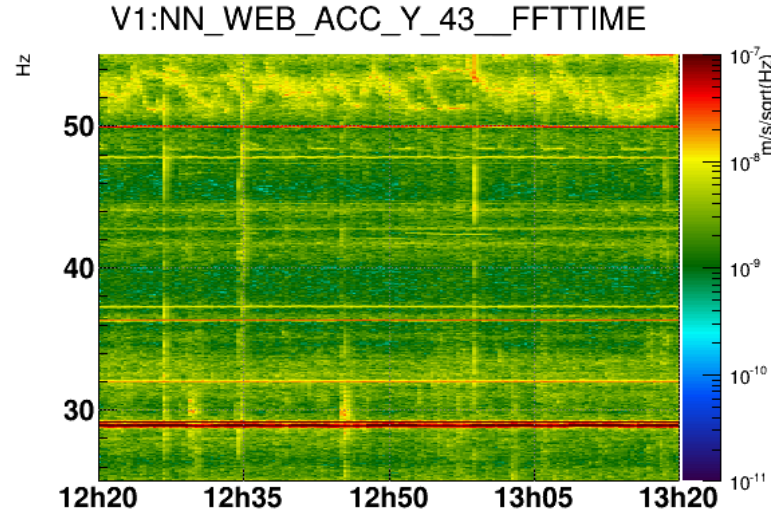


# Newtonian sensors

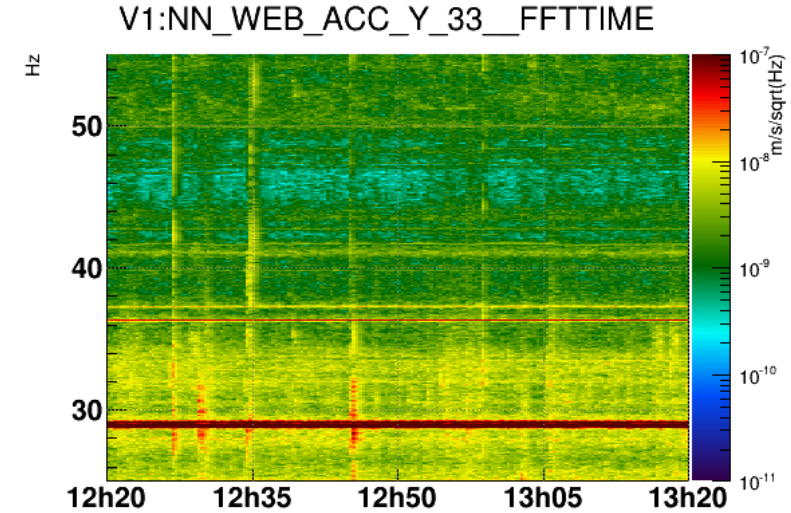
dataDisplay v10r9p2 : started by pierini on Jun 18 2021 12:52:41 UTC



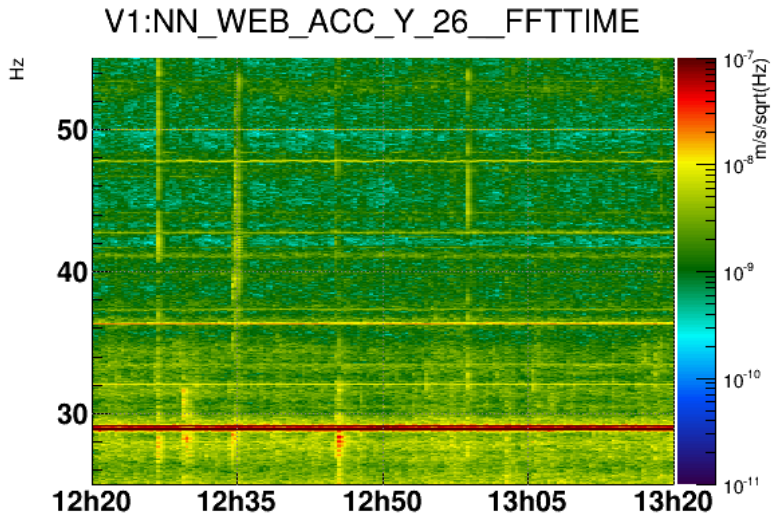
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



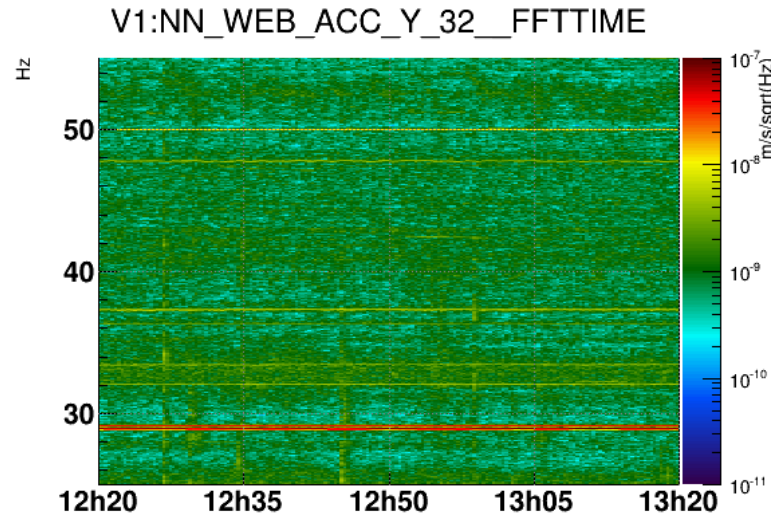
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

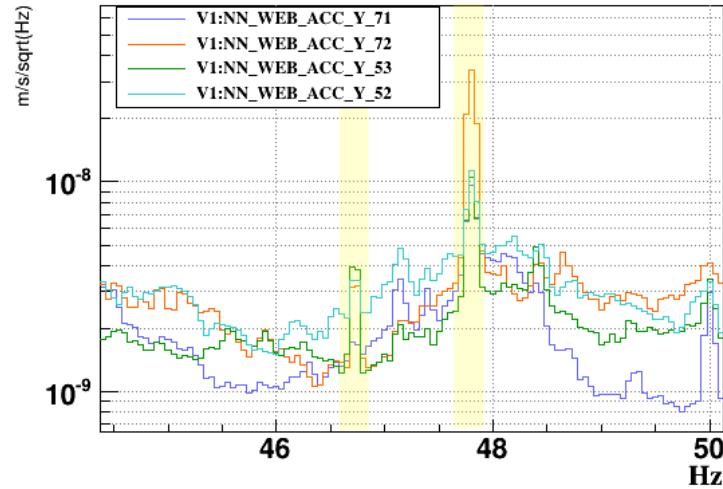


1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2

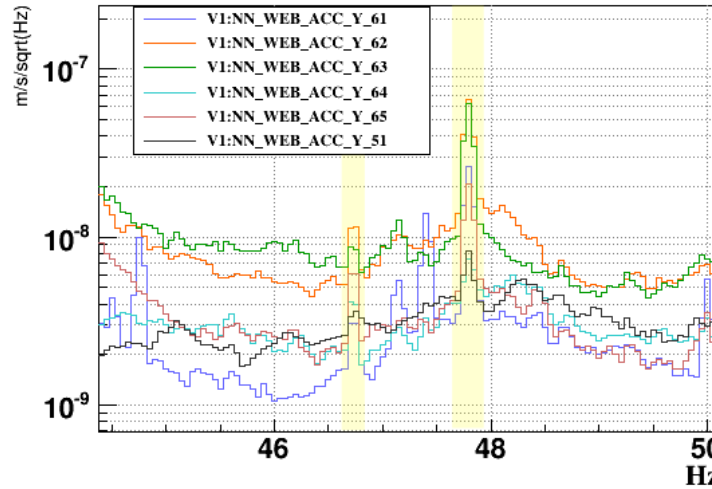


# Newtonian sensors

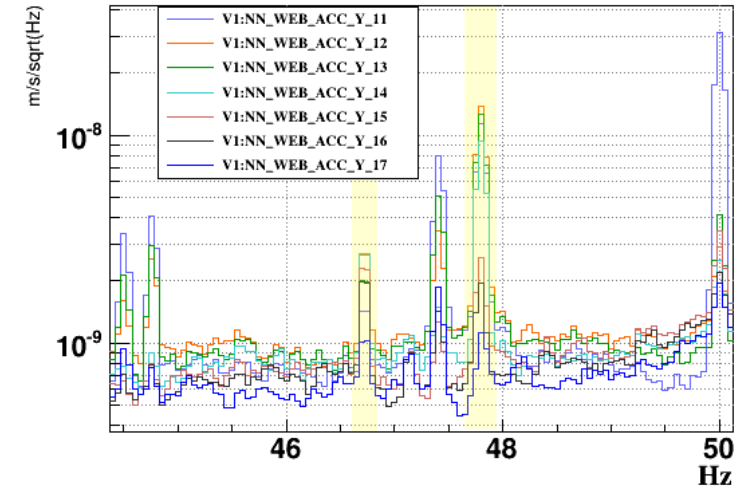
dataDisplay v10r9p2 : started by pierini on Jun 18 2021 14:39:14 UTC



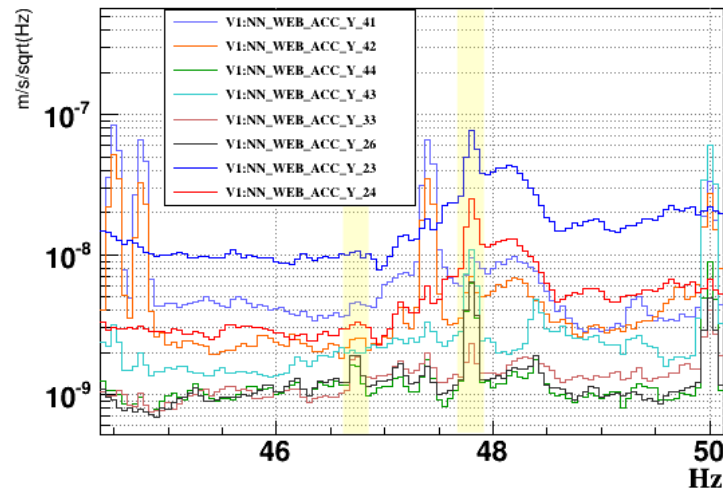
1307881688.00 : Jun 16 2021 12:27:50 UTC dt:20.00s nAv:48



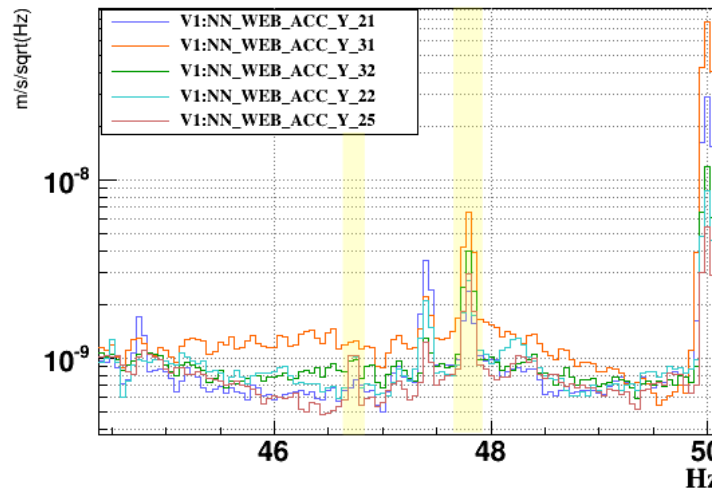
1307881688.00 : Jun 16 2021 12:27:50 UTC dt:20.00s nAv:48



1307881688.00 : Jun 16 2021 12:27:50 UTC dt:20.00s nAv:48



1307881688.00 : Jun 16 2021 12:27:50 UTC dt:20.00s nAv:48

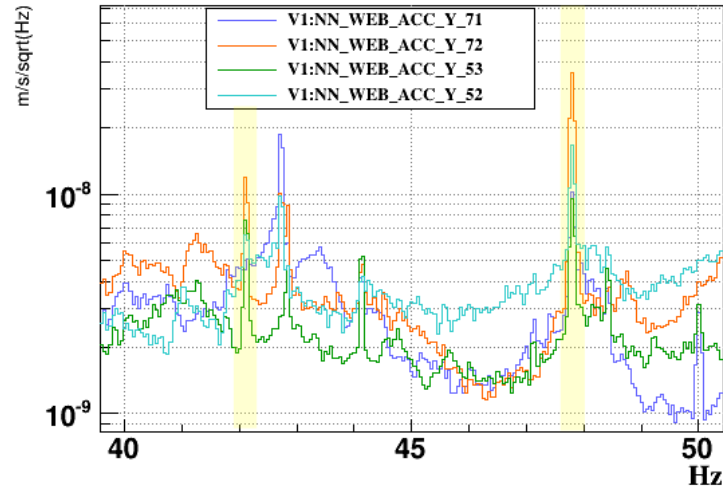


1307881688.00 : Jun 16 2021 12:27:50 UTC dt:20.00s nAv:48

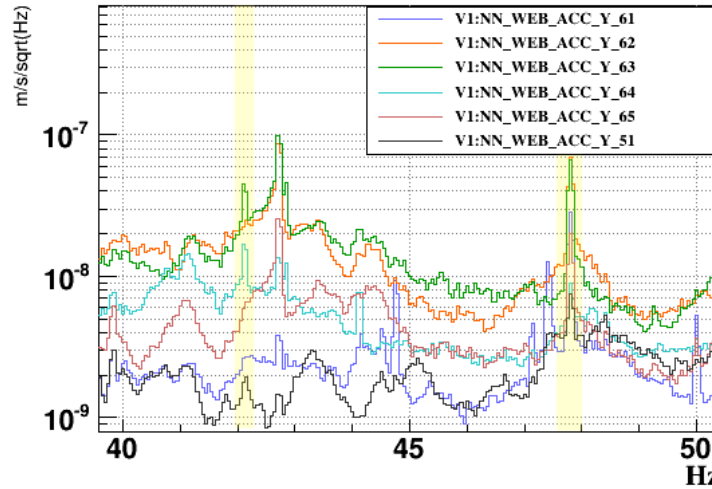
Cold pump +  
Right hot pump  
@ 50 Hz

# Newtonian sensors

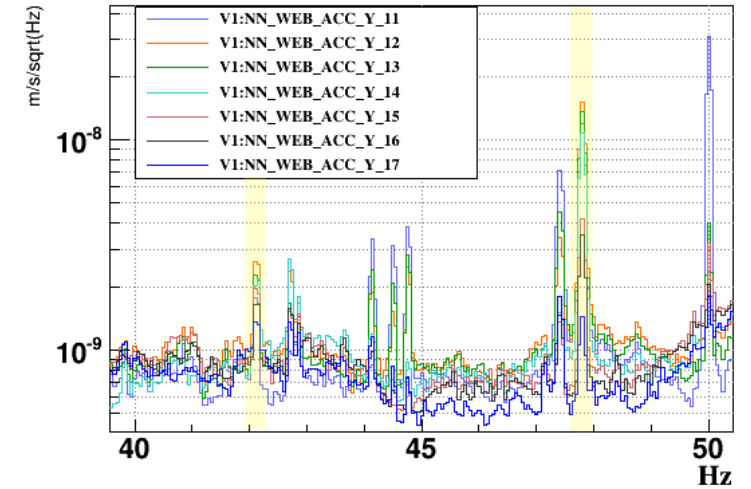
dataDisplay v10r9p2 : started by pierini on Jun 18 2021 15:17:43 UTC



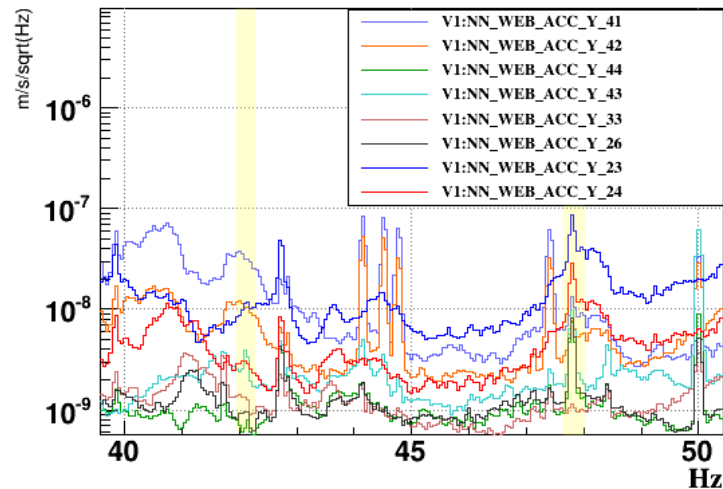
1307883088.00 : Jun 16 2021 12:51:10 UTC dt:20.00s nAv:48



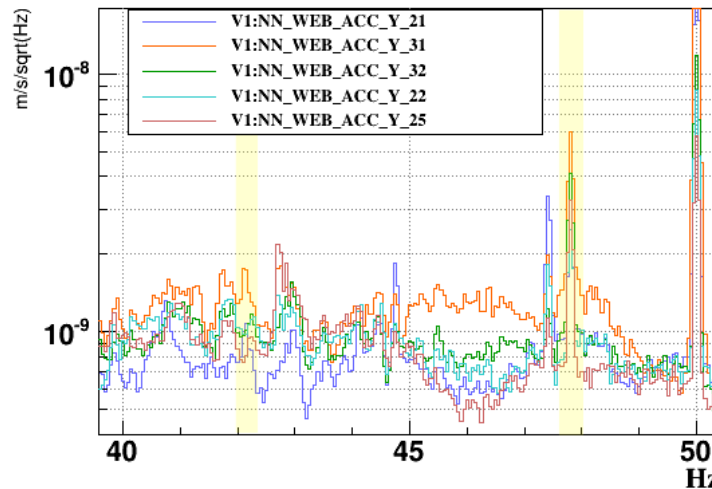
1307883088.00 : Jun 16 2021 12:51:10 UTC dt:20.00s nAv:48



1307883088.00 : Jun 16 2021 12:51:10 UTC dt:20.00s nAv:48



1307883088.00 : Jun 16 2021 12:51:10 UTC dt:20.00s nAv:48

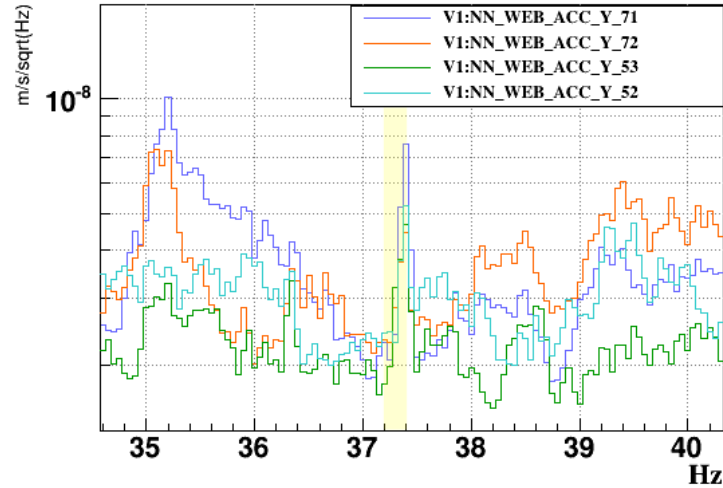


1307883088.00 : Jun 16 2021 12:51:10 UTC dt:20.00s nAv:48

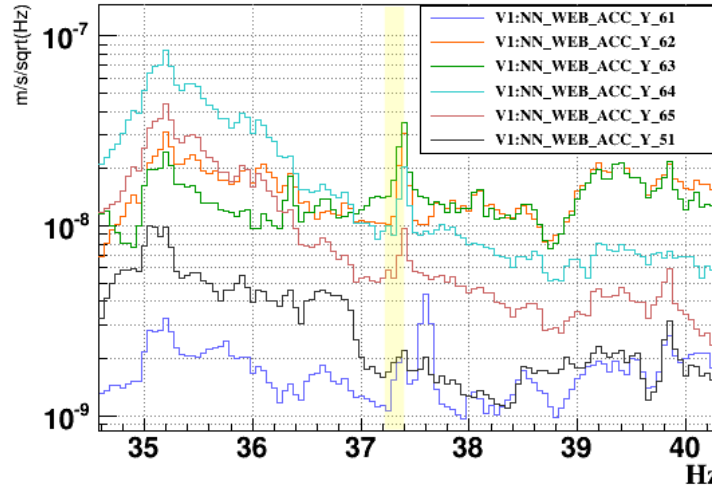
Cold pump +  
Right hot pump  
@ 45 Hz

# Newtonian sensors

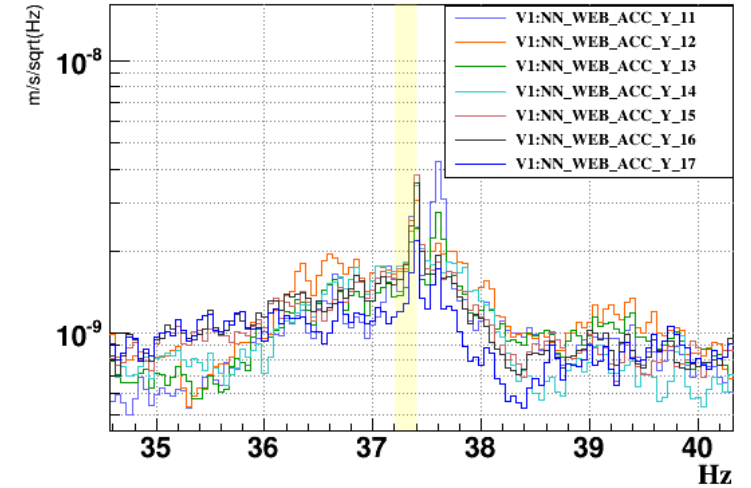
dataDisplay v10r9p2 : started by pierini on Jun 18 2021 17:11:31 UTC



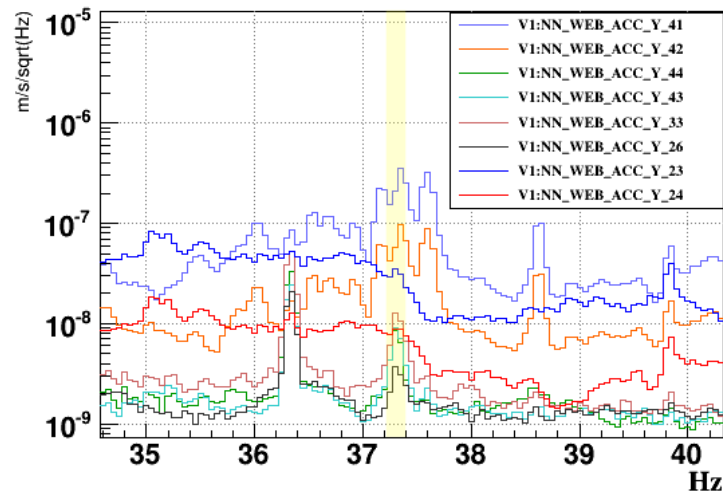
1307884028.00 : Jun 16 2021 13:06:50 UTC dt:20.00s nAv:36



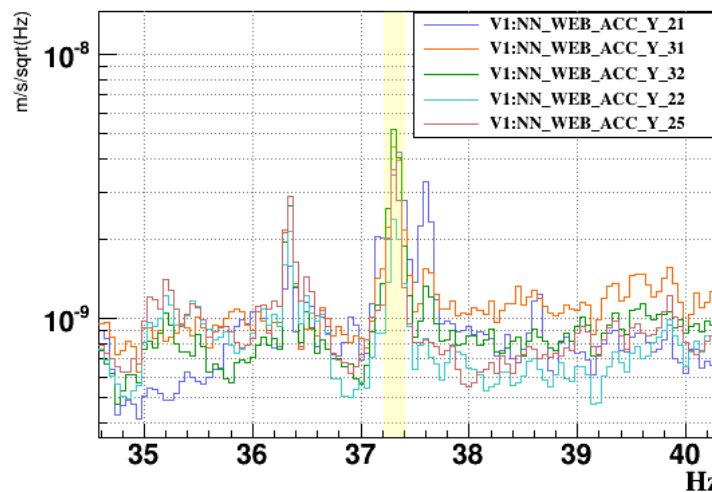
1307884028.00 : Jun 16 2021 13:06:50 UTC dt:20.00s nAv:36



1307884028.00 : Jun 16 2021 13:06:50 UTC dt:20.00s nAv:36



1307884028.00 : Jun 16 2021 13:06:50 UTC dt:20.00s nAv:36

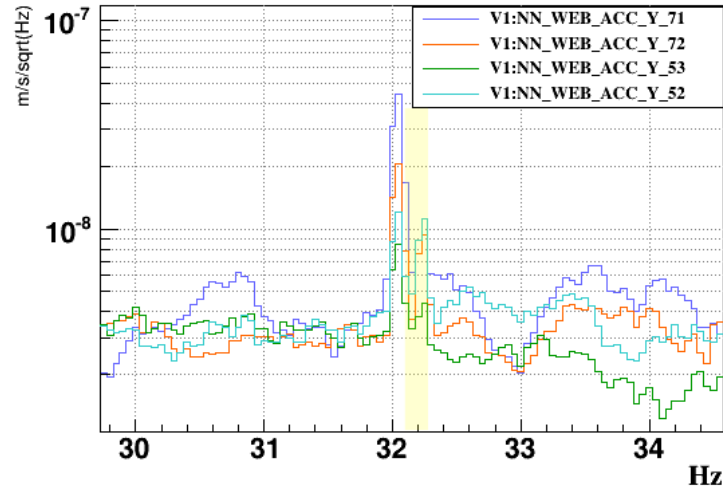


1307884028.00 : Jun 16 2021 13:06:50 UTC dt:20.00s nAv:36

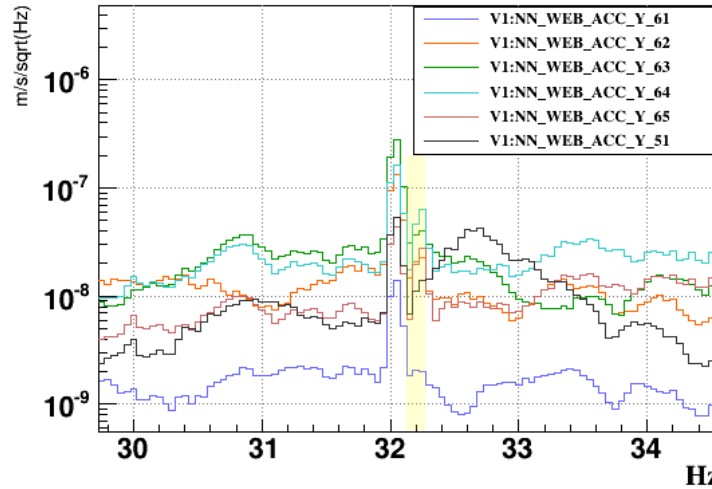
Right hot pump  
@ 40 Hz

# Newtonian sensors

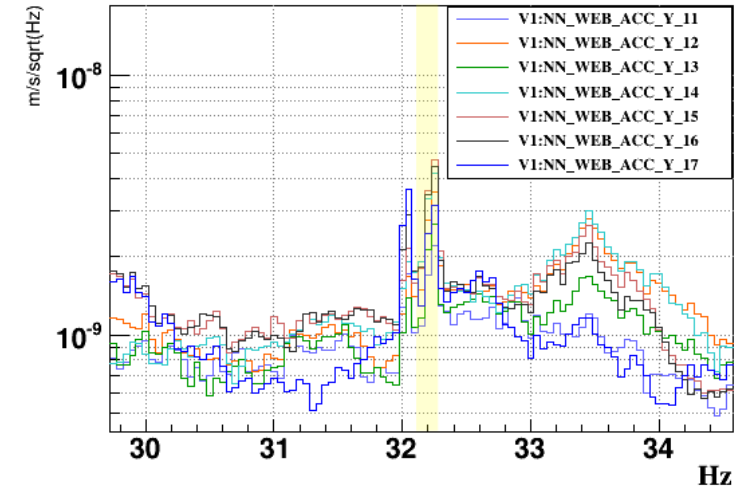
dataDisplay v10r9p2 : started by pierini on Jun 18 2021 17:24:42 UTC



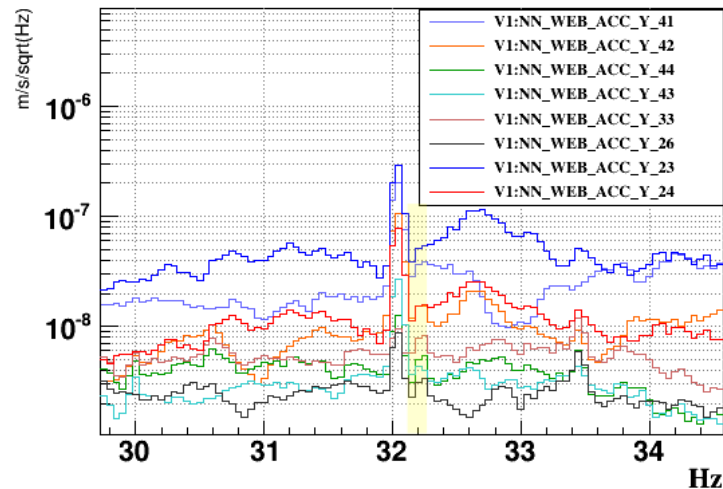
1307884478.00 : Jun 16 2021 13:14:20 UTC dt:20.00s nAv:36



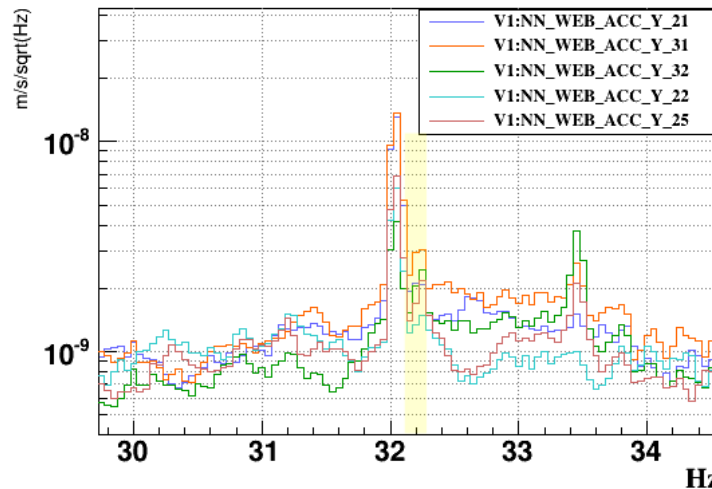
1307884478.00 : Jun 16 2021 13:14:20 UTC dt:20.00s nAv:36



1307884478.00 : Jun 16 2021 13:14:20 UTC dt:20.00s nAv:36



1307884478.00 : Jun 16 2021 13:14:20 UTC dt:20.00s nAv:36



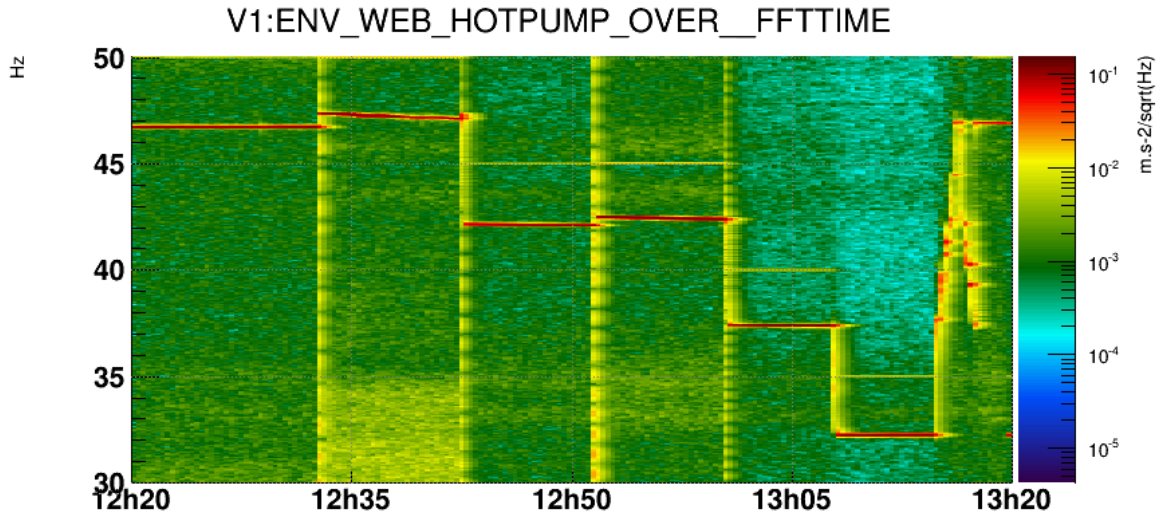
1307884478.00 : Jun 16 2021 13:14:20 UTC dt:20.00s nAv:36

Right hot pump  
@ 35 Hz

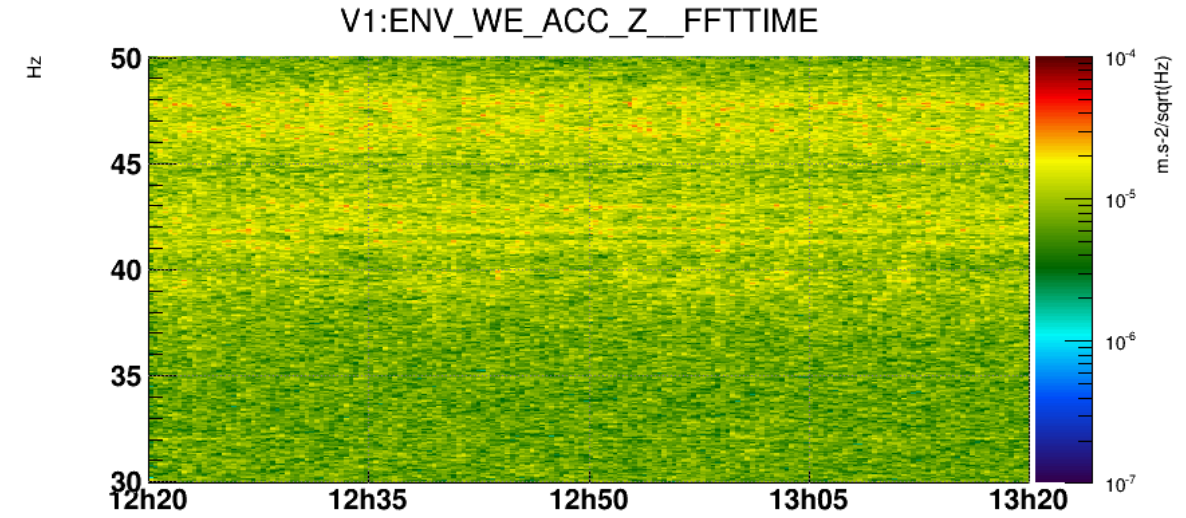


# West-End accelerometers

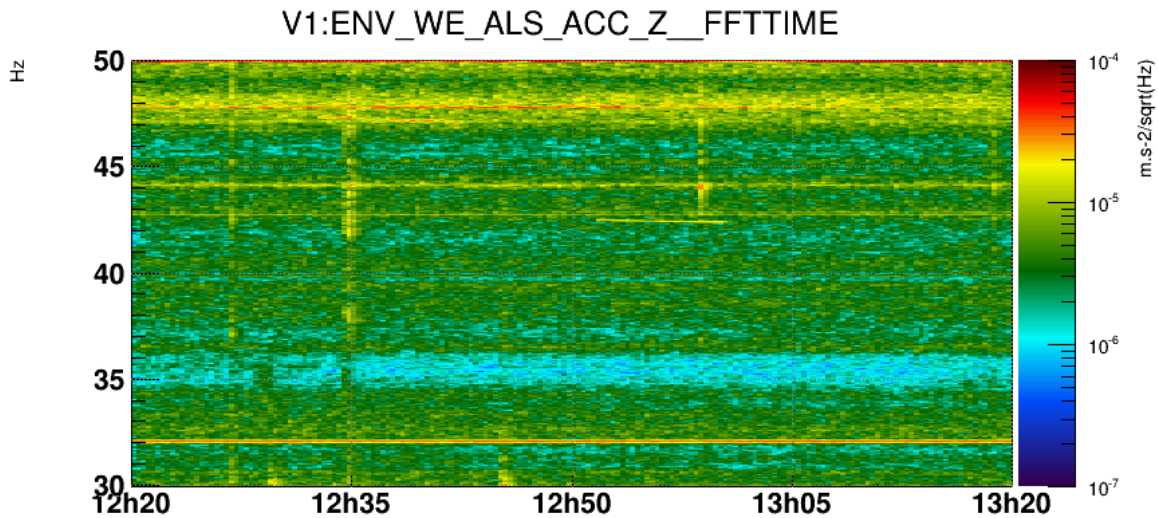
dataDisplay v10r9p2 : started by pierini on Jun 23 2021 11:42:46 UTC



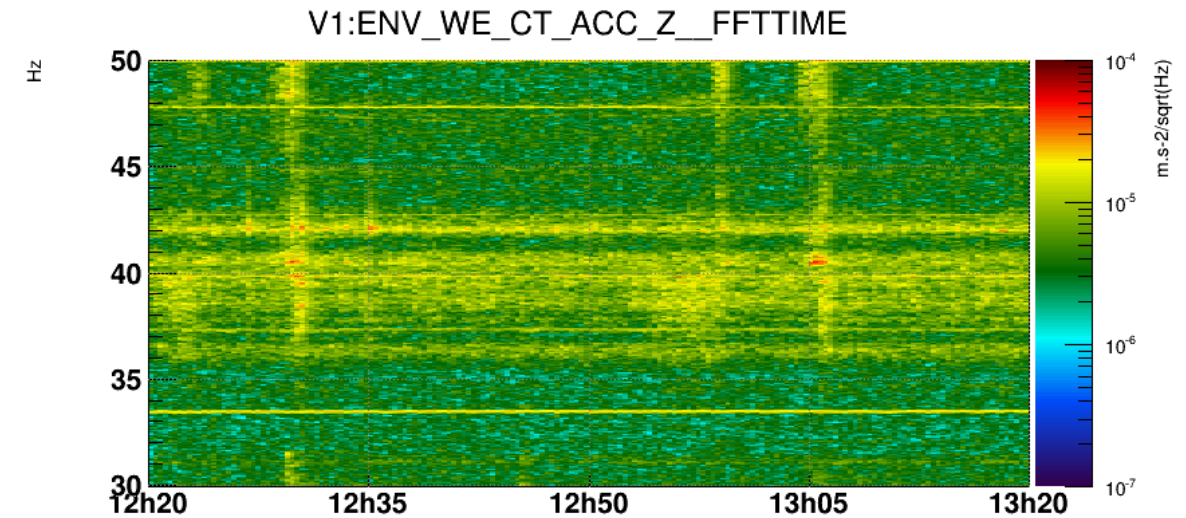
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



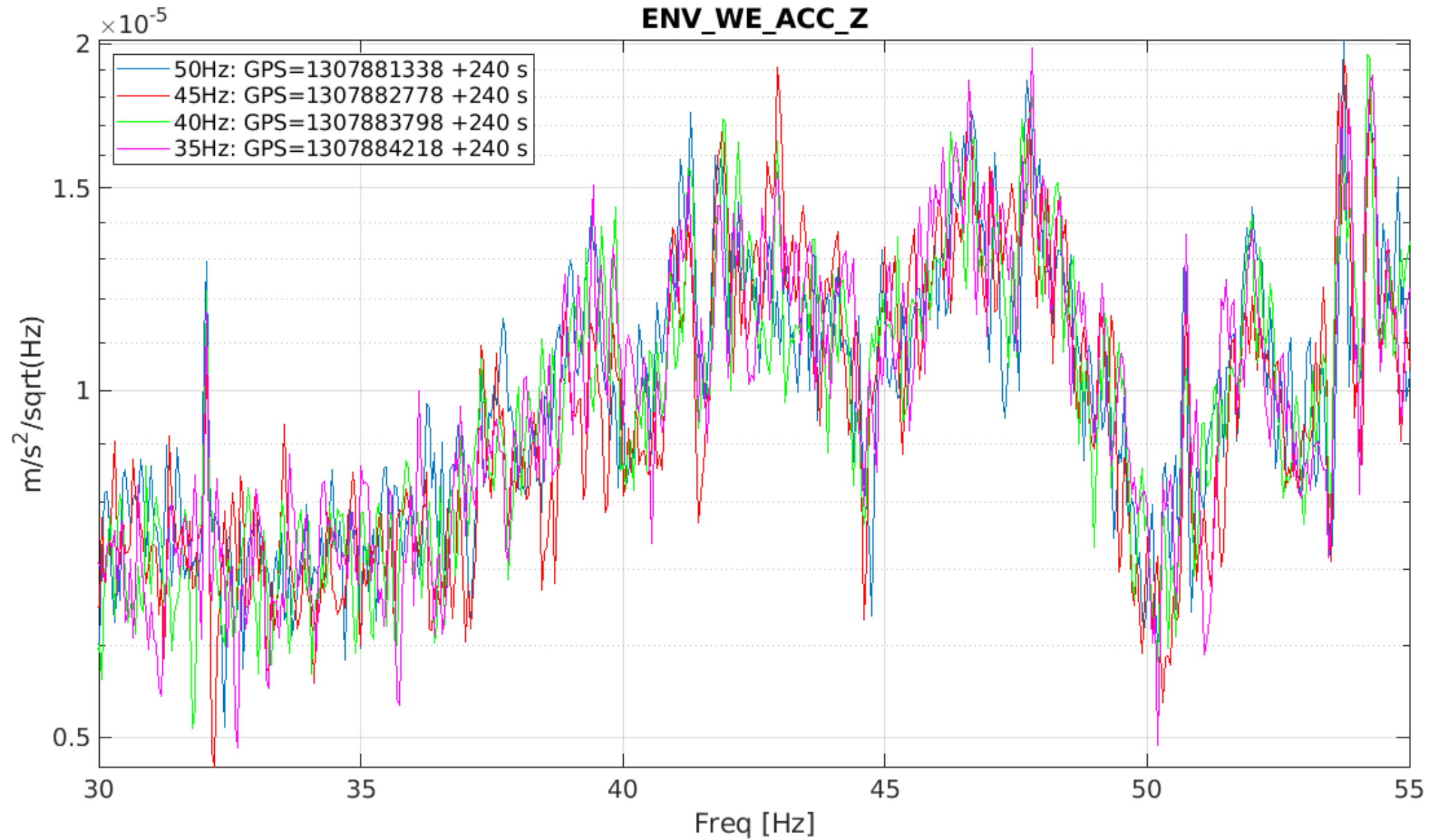
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



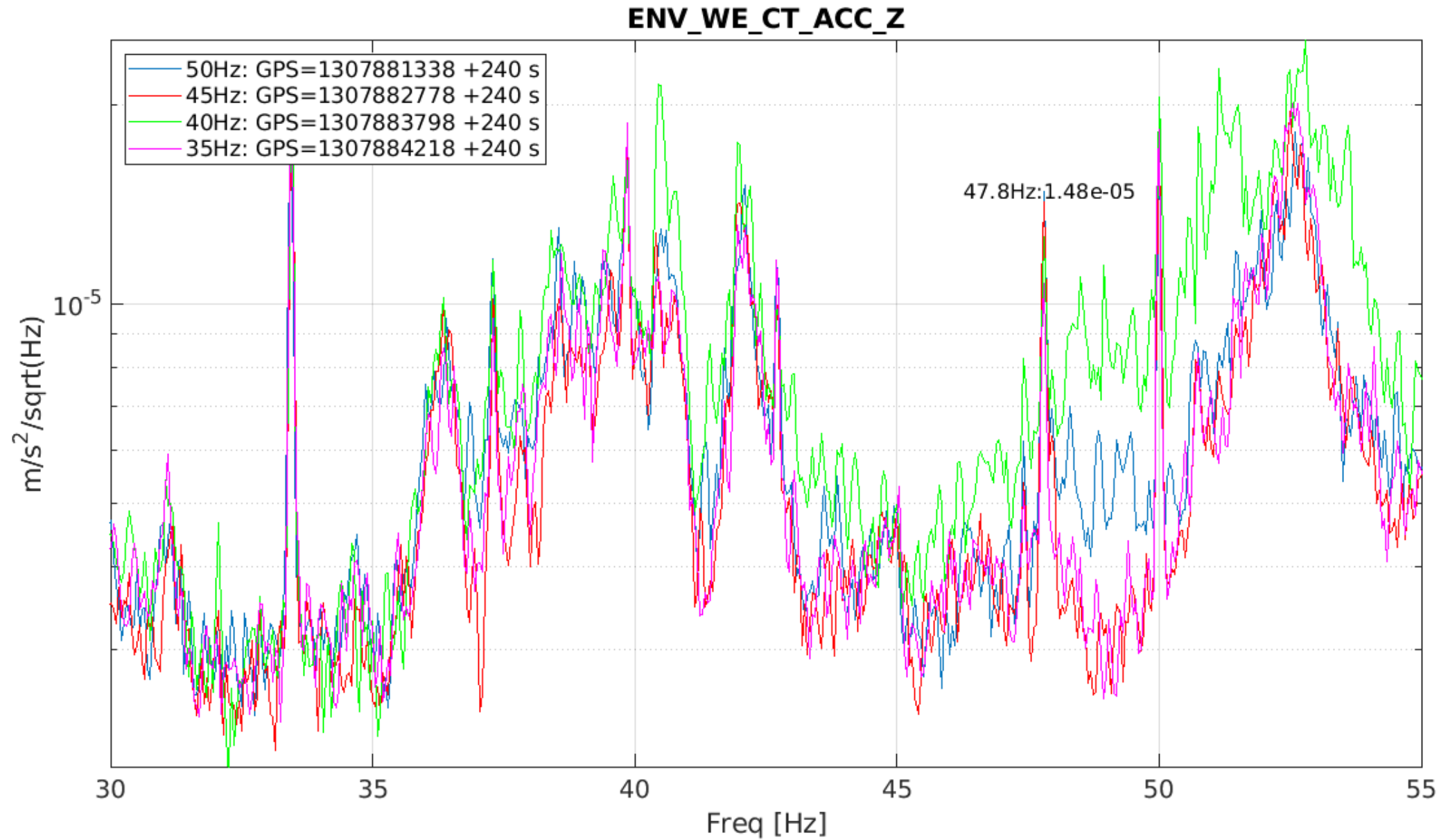
1307881218.00 : Jun 16 2021 12:20:00 UTC dt:20.00s nAv:2



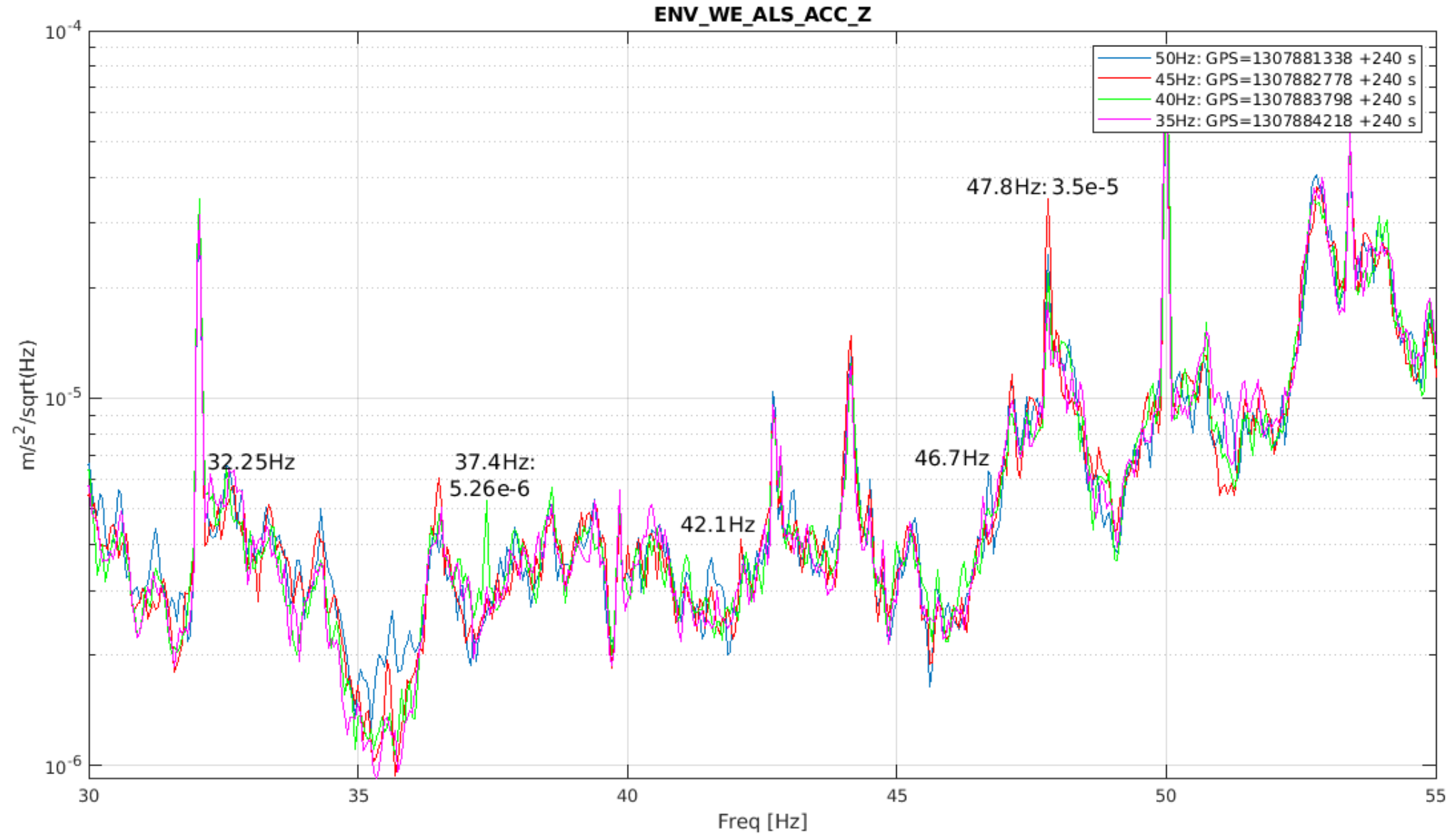
# West-End accelerometers



# West-End accelerometers



# West-End accelerometers





# West-End accelerometers

dataDisplay v10r9p2 : started by pierini on Jun 23 2021 12:10:04 UTC

